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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Proposed Specification for Grey Iron Castings.

Elsewhere in this issue is outlined the tentative specification for the strength of grey iron castings, which has been formulated by a committee of the Institution of British Foundrymen. In a letter which the convener, Mr. J. Shaw, of Sheffield, has circulated with the specification it is distinctly stated that the proposals do not cover all points at issue, such as propellers and other castings with greatly varying sectional thickness.

In principle, the specification which is to be submitted for the approval of members at the Manchester Conference proposes three cylindrical bars of increasing diameters, which will more or less conform to the average thickness encountered in normal grey iron foundry practice. It is pointed out in the circular letter referred to that the Committee claim for the specification submitted that it will eliminate anomalies associated with the return of a high result from a tensile test bar of small cross-sectional area, due to the influence of rapid cooling on the structure of the sample, or with the specification of a definite breaking load on the one-size bar without any reference to the thickness of the casting it is supposed to represent, or with the specifying of the British Engineering Standards Association tests by engineers to castings which were never meant to be included in such.

The specification is essentially an honest attempt to place the mechanical testing of cast iron on a basis, acceptable alike to both foundryman and the buyer. It is interesting to note that the Committee composed of representatives from all the large foundry areas throughout Great Britain was practically unanimous in their decision to recommend three bars, each bearing some relationship in thickness to the casting it is to represent. Added importance is given to this specification as the British Cast Iron Research Association have independently arrived at a somewhat similar conclusion. It is to be hoped that finally the two committees will be in a position jointly to issue a specification suitable for national acceptance and international consideration.

As foundrymen are in agreement that sharp corners should be avoided, the Committee recommend a cylindrical bar for transverse testing, the tensile test piece to be machined from the former when broken.

In his letter, Mr. Shaw puts forward as the reason for their choice of the 0.875 in. dia. bar, that it conforms with several B.E.S.A. specifications, and for the 1.20 in. dia. bar, that it was this size that the British representatives put before the last meeting of the International Society, with the proviso that the length of the bar should be adequate for registering correct deflections. It is pleasing to state that the chairman of the American Society for Testing Materials, Mr. Walter Wood, put forward this particular bar as the "International" bar, so as to fall into line with the tentative specification. As the majority of tests will be made from this bar, it will allow of ready comparison to be made with foreign tests.

The majority of the Committee are stated to have been in favour of machining the transverse bar, but, as Mr. Shaw points out, such a system would be a serious charge upon the manufacturers of cast-iron pipe and others who have to make a large number of tests each day. Additionally, being cylindrical, cracks and other surface defects should be at a minimum.

Foundrymen will realise that provision is made, by the insertion of clause, for heat treatment. This is wise, as it is a practice which is more likely to increase than diminish.

The highest American figures on their arbitration bars (1.25 in. bar tested at 12 in. centres) are 3,300 and 2,900 lbs., are equivalent to 1,915 lbs. for Class A and 1,715 lbs. for Class B when using the 1.2 dia. bar tested at 18-in. centres.

The tensile loads proposed are all in present use and are embodied in various B.E.S.A. specifications, with the exception of the largest bar. Mr. Shaw does not anticipate that foundrymen will meet with any difficulty in meeting the tests proposed, except the largest bar, which will not give an equal test due to its size, as the slower cooling effect will produce a more open centre and obviously lower the result. From experience he has found, however, that, with suitable metal, no difficulties have been encountered.

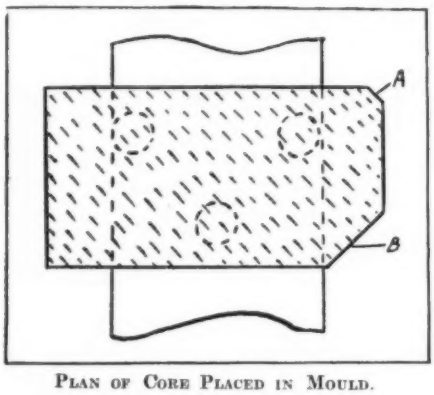
The Patternshops and Foundry Interests.

By F. C. Edwards.

From a commercial point of view the patternmaker is frequently regarded as a "necessary evil." Beyond doubt, he is a necessary intermediary between the drawing office and the foundry, and his power, either for good or evil, is unquestionably very great. Given the right mental attitude, and that freedom of action which is an essential requisite for the exercise and development of initiative, the patternmaker should indeed prove to be the foundry's most beneficent friend.

What is true of the unit certainly applies, in this case, with correspondingly greater force to the mass; and, other things equal, that foundry will have the highest output, and the least percentage of scrap, where the patternshop as a whole—from foreman to apprentice boy—realises that its first and last duty is to study the interests of the foundry.

What can be done to improve the design so as to secure the best results *from the foundry point of view*? This query should be the foreman's uppermost thought, as he scans the blue print before placing it in the shop. A somewhat similar question, applied to alternative methods of jointing, etc., should agitate the mind of the patternmaker as he passes from step to step in the construction of the job. And the importance



Plan of Core Placed in Mould.

of properly varnishing and rubbing-down a pattern, making sure that loose pieces are actually loose, and so on, should be impressed on the mind of the apprentice as early as possible. Always, the path of least resistance *from the foundry point of view* should be diligently sought.

The cultivation of this mental attitude throughout his shop ought to receive the unremitting attention of the foreman. He should preach—in season and out of season—that it is not enough merely to make a pattern to the blue print; but that each successive step in *moulding* the job should be anticipated.

If this practice was more generally followed there would be less of that class of scrap which is often the cause of friction between the foundry and the pattern shop, and which the wideawake foundry manager usually is correct in attributing to patternshop negligence. That it is indeed negligence, rather than lack of knowledge, is evident from the fact that even the most experienced patternmaker is occasionally caught napping in these matters.

A fairly common "oversight" in this connection is that where loose portions of a pattern, owing, say, to the unfortunately symmetrical arrangement of the dowels, can easily be made to assume other positions on the pattern besides the right one. Another contributory cause of scrap is found in the lack of definite and unmistakable locating points on core prints in those cases in which the cores, apparently uniform in shape, yet contain vital differences which require the cores to be placed in one way and one way only.

Worst Type of Scrap.

Of all the various cases of scrap, those of the latter class are particularly annoying—because they are so easily preventible. They will seldom if ever occur where the patternmaker visualises the subsequent moulding operations; by cultivating imagination and placing himself in the position of the moulder as he is coring up his mould he should be able to detect and to eliminate all ambiguous situations that are likely to crop up.

In arranging the locating points, it must always be remembered that the bottom of a mould is generally too dark to distinguish fine variations of contour. Consequently (if no other part of the coreprint is suitable for this purpose), these guides should be sufficiently prominent so that the core, if it is incorrectly placed in the mould, will "ride" on the obstruction: that it will be *felt*, if not seen.

It occasionally happens, however, that the moulder cuts away the "obstruction," and forces the core—willy nilly—to assume a wrong position in the mould. In such cases, of course, the patternshop is not directly culpable—though it may have contributed *indirectly* to what appears to be gross carelessness on the part of the moulder. If, for instance, the general standard of agreement between cores and their respective coreprints is not what it should be (thanks, probably, to neglect of foundry interests by the patternshop), the moulder automatically acquires the baneful habit of rubbing the core to fit the print, or of making up the mould where the print is deficient. Accustomed to removing, without hesitation, hindrances carelessly left in his path of production, he may perhaps be excused if, at times, he inadvertently treats in the same manner a "finger post" especially set up for his guidance.

The best method of ensuring the correct locating of a core, however, is to make a glaring distinction between the respective ends or sides of the coreprint *seen in plan as moulded*. How *not* to do this is shown at A, Fig. 1, where the core is represented by dotted section. Such a ridiculously small "corner"—especially if the mould happens to be disturbed on the withdrawal of the pattern—is of no use whatever as a guide to the moulder in positioning the core. Moreover, the other corners of the core also may be accidentally rubbed off, in handling, to the same extent. Corner B, on the other hand, clearly indicates to the moulder how to place his core without the necessity of trying it in the mould in various positions, or of applying to the patternshop for information on the point.

These, and similar, apparently minor details in patternmaking, have a greater bearing on the smooth and efficient running of the foundry than is, perhaps, generally supposed. Attention to such details can alone confer that final touch of perfection to a pattern which denotes that its creator not only understands how to construct patterns, but—(and this is the supreme qualification to the title of patternmaker)—that he has a clear conception of the manner in which they will be used.

Messrs. Grardige & Mansergh, Limited, have changed their address to Wheathill Street Works, Blackfriars Road, Salford, Manchester.

Mr. J. W. Sutcliffe, a director of Hartley & Sugden, Limited, boiler makers, of Gibbet Street, Halifax, died recently, aged seventy-six.

F. Wertenbruch, who has now changed his name to Frank W. Brooke, was a student in the metallurgical department of Sheffield University. He is now chief engineer to Messrs. William Swindell & Brothers, of Pittsburgh, U.S.A., and recently gave a Paper on "Electricity in the Foundry" to the Pittsburgh Foundrymen's Association.

British Pigirons, Limited, Abbey House, 2, 4, 6 & 8, Victoria Street, Westminster, London, S.W.1, state that they are now represented by Mr. E. Cedric O'Brien, late of the Northampton Institute and of the Engiish Electric Company, Limited, and Mr. Rex A. Howard, late of R. A. Lister & Company, Limited. In addition to these gentlemen they have seven other resident representatives in various parts of Great Britain. Overseas they are represented by seventeen firms, so that their organisation is practically complete, with the exception of the Paris office, which the company are hoping to open shortly.

Moulding Sands.*

By O. Smalley, M.I.Brit.F.

In these days of scientific enlightenment and commercial enterprise it is customary for the manufacturer to purchase his raw materials to a rigid specification calling for tests which amply cover his requirements. The engineer, for example, clearly defines the physical properties of his materials of construction, and controls them within a very narrow margin. In the production of castings the foundryman must either work to these rigid specifications or have his products left on his hands. Therefore he in turn must exert a similar control over his own raw materials, if he aspires to any measure of success. It is singular, however, that even to-day the control of the raw materials in the foundry is the exception rather than the rule. Particularly does this apply to moulding sands. In Great Britain, the prevailing custom is "to order the same as before," or to test by feel and by bond, gripping a handful and breaking and examining the fracture by eye. These methods, which have come about from the excellent natural resources of suitable moulding sands of this country, are none the less deplorable. It is with great reluctance that the foundryman will try a new sand if the one already in use is giving any measure of satisfaction, and any advantages to be derived are frequently diluted by his scepticism, and more often than not it is impossible to say how far a new sand is responsible for changed results. In America, the absence of suitable natural moulding sands and their intensive mass production has necessitated the preparation of artificial sands of requisite chemical and physical characteristics.

This obviously has demanded a closer study of the requirements of a suitable moulding sand, and although it would be unfair to say that America is producing better castings than we are, her necessity has made her a skilful exponent in the standardisation of moulding sands. The following specification, issued by a large American locomotive corporation, gives some idea of their scientific method of purchase, and clearly demonstrates the rigid control enforced.

SPECIFICATION FOR MOULDING SAND. No. 298.

Sand purchased under this specification must be reasonably free from stones, dirt, silt, and organic matter, such as roots, decomposed vegetation, etc.

Three kinds of sand will be considered, viz.: silica or fire sand, moulding sand, and core sand. These sands will be classified according to their chemical composition, and graded, according to the degree of fineness, into five distinct grades or numbers, as follows:—

Grade.	*Degree of Fineness.*
No. 1 Superfine	Above 100 per cent.
No. 2 Fine or Light.	100 to 90 ,,
No. 3 Medium.	90 to 75 ,,
No. 4 Coarse or Heavy.	75 to 55 ,,
No. 5 Extra Coarse.	55 to 30 ,,

In specifying the fineness of sand, the above numbers will be used, and will apply to silica, moulding, and core sand.

No sand will be accepted which varies more than 5.00 per cent. from the grade designated at the time of purchase.

Silica or Fire Sand.—This material is used for refractory work, tempering high-bond moulding sand, mixing with fine clay for steel-casting purposes and for grinding.

Good fire sand will usually run about 98.00 per cent. of silica, with very little alumina, lime, magnesia, or combined water, and not more than a mere trace of iron.

No fine sand will be accepted which shows, on analysis, less than 95.00 per cent. of silica, more than 4.00 per cent. of alumina, and more than 1.00 per cent. of lime.

* A Paper read before the London Branch of the Institution of British Foundrymen, Mr. Wesley Lambert presiding.

The following analysis of an average fire sand will give some idea as to what is desired:—Silica (SiO_2), 98.04; alumina (Al_2O_3), 1.40; iron (Fe_2O_3), 0.06; lime (CaO), 0.20; magnesia (MgO), 0.16; and combined water (H_2O), 0.14. The specific gravity is to be 2.592.

Moulding Sand.—Moulding sand for iron work generally contains from 75.00 to 85.00 per cent. of silica, 5.00 to 13.00 per cent of alumina, usually less than 2.50 per cent. of lime and magnesia, not over 0.75 per cent. of fixed alkali (soda and potash), generally less than 5.00 per cent. of iron, and seldom more than 4.00 per cent. of combined water.

Sand for Brass Moulding.—This may contain a much higher percentage of iron and lime, without doing any particular harm.

All moulding sands usually contain some organic matter, generally present in the form of small roots or as decomposed vegetable matter.

We do not expect to *buy* a sand with an *exact chemical composition*, as this is almost an impossibility, the same bed of sand often varying several per cent. in silica and alumina at different places; we do, however, *reserve the right to reject* any sand not of the *required degree of fineness*, or that contains an excessive amount of *carbonate of lime, magnesia, iron and organic matter.* Our limit for the objection elements is as follows:—

Carbonate of lime must not exceed 1.50 per cent. in an iron moulding sand, and should not exceed 2.25 per cent. in a brass sand.

Iron must not exceed 5.50 per cent. in the iron moulding sand or 7.00 per cent. in a brass sand.

Organic matter must not exceed 1.00 per cent., and preference will be given sands running lower in organic matter.

Clay and silt are objectionable, consequently any sand showing on analysis more than 13.00 per cent. of alumina will be rejected. (See note.)

Table I., detailing the analyses of moulding sand, will give some idea as to their chemical composition:—

TABLE I.—*Analyses of Moulding Sands.*

	Light Iron Works.	Medium Iron Works.	Heavy Iron Works.	Light Brass Works.
Silica (SiO_2)	82.21	5.85	88.40	78.86
Alumina (Al_2O_3) ..	9.48	8.27	6.30	7.89
Iron Oxide (Fe_2O_3) ..	4.25	2.32	2.00	5.45
Lime Oxide (CaO) ..	—	0.50	0.78	0.50
Lime Carb. ($CaCO_3$)	0.68	0.29	—	1.46
Magnesia (MgO) ..	0.32	0.81	0.50	1.18
Soda (Na_2O)	0.09	0.10	—	0.13
Potash (K_2O) ..	0.05	0.03	—	0.09
Manganese (MnO) ..	—	—	0.25	Tr.
Combined Water(H_2O)	2.64	1.68	1.73	3.80
Organic Matter ..	0.28	0.15	0.04	0.64
Specific Gravity ..	2.652	2.645	2.630	2.640
Degree of Fineness ..	95.18	66.01	46.86	94.88

So far as the chemical composition is concerned, any one of the above sands would answer fairly well for nearly any class of work, but it is *absolutely necessary* that the proper degree of *fineness* be carefully considered.

Core Sand.

The quality or chemical composition of a core sand, according to some authorities, is of minor importance, the degree of fineness being the main feature.

As a rule, a good core sand should be high in silica and low in alumina.

The bond for core sand is obtained by adding resin, flour, etc., consequently the desired effect is produced with a high silica sand or with a sand low in alumina and iron.

A sand low in alumina and iron will permit of the rapid escape of the gases, whereas a high alumina or a clay sand bakes and holds back the gases.

The analyses shown in Table II., although radically different, are good core sands, due entirely to low alumina and iron.

Objection will be made to core sands containing more than 5.00 per cent. of alumina or more than 2.50 per cent. of iron.

When a shipment of sand is received, the inspector will select three samples of about 2 lbs. each from different parts of the car, and these samples will be sent to the laboratory for examination.

The sand, after being thoroughly mixed by machinery, will first be weighed, then dried at a temperature of 220 deg. F. (103 deg. C.) for one hour, or until perfectly free from moisture; the difference or loss in weight of the moist sand and the dry sample will represent the amount of moisture present.

TABLE II.—*Analyses of Core Sands.*

	Extra Quality Core Sand.	Fair Quality Core Sand.
Silica (SiO_2)	94.30	69.31
Alumina (Al_2O_3) ..	1.95	4.76
Iron Oxide (Fe_2O_3) ..	0.33	1.58
Lime Carb. ($CaCO_3$) ..	1.63	3.50
Lime Sulphate ($CaSO_4$)	—	8.19
Magnesia (MgO) ..	0.54	7.77
Alkalies (Na_2OK_2O) ..	0.05	0.12
Combined Water (H_2O)	1.05	2.95
Organic Matter	0.15	1.82

The degree of fineness and the chemical analysis are to be determined by the dry sample.

The apparatus required for estimating the percentage or degree of fineness consists of a scale or balance sensitive to one centigramme, or a tenth of a grain, and a set of five inch U.S. Standard brass sieves, of the following mesh, viz., 100, 80, 60, 40 and 20.

These sieves are fitted with a cover and a bottom pan, and may be used separately or in combination; they may be obtained of any dealer in chemical apparatus.

Method of Determining the Degree of Fineness.

Exactly 100 grams (or, if preferred, 1,000 grains) is carefully weighed out and entered into the 100-mesh sieve, which has been previously placed upon the bottom pan.

The sieve is now shaken for exactly one minute, mostly sidewise, but occasionally up and down to free the meshes of sand. At the end of one minute the bottom pan is removed, the sand weighed that has passed through, and the weight credited to the 100-mesh sieve.

The sand remaining on the 100-mesh sieve is then emptied into the 80-mesh sieve, placed upon the bottom pan as before, and the sieve just used is thoroughly cleaned with a stiff stencil brush.

The 80-mesh sieve is shaken as before for exactly one minute, and the sand which has passed through is carefully weighed and credited to the 80-mesh grade.

In similar manner, 60-, 40- and 20-mesh sieves are used, each receiving credit respectively.

The amount of sand passing through the sieve, multiplied by the number of the mesh, and the sum of the several results divided by 100, will give the average per cent. or degree of fineness of the sample.

Usually there is a small loss, due to dust and to small particles of sand remaining in the meshes.

Using a set of sieves as described above, the average mesh of the series will be 60, consequently any loss sustained should be multiplied by this figure and added to the total amount.

In case there should be some coarse material remaining on the 20-mesh sieve, it is weighed and credited to a No. 1 mesh.

The following example will more clearly illustrate the method and calculation:—

Weight of sand passing through.		Number or Mesh of sieve.		
55.22 grams.	×	100 mesh	=	5522.00
20.89 „	×	80 „	=	1671.20
11.64 „	×	60 „	=	698.40
10.57 „	×	40 „	=	422.80
1.20 „	×	20 „	=	24.00
0.06 „	×	1 „	=	0.06
99.58				
0.42 (loss)		60 „	=	25.20
				8363.66

8363.66 divided by 100 = 83.64 per cent., which is assumed to be the correct degree of fineness.

In cases of dispute, it is customary to make duplicate determinations of the degree of the fineness, and take the average as an absolute figure.

If the test is carefully carried out, there should be very little loss, and duplicate determinations should not vary more than 2 per cent.

Note.—The following remarks on the effect of certain elements in sand will give some idea as to what is desired, and to what is considered objectionable:—

Silica is the fire-resisting element; *it has no bond*, i.e., binding property, consequently in a sand where adhesiveness is required, alumina must be present; silica alone is very refractory, but in the presence of the fluxing elements, iron, lime, magnesia, soda and potash, it readily fuses and forms silicates. These silicates fuse or melt at about the following temperatures:—Silicate of alumina, 2,395; silicate of magnesia, 2,180; silicate of lime, 2,095; silicate of iron, 1,795; and silicate of soda, 700 deg. C.

When soda or potash is present, silicates are formed at low temperatures.

Iron melts from 1,205 to 1,260 deg. C., consequently a sand containing much iron, lime and alkali will burn or fuse into the molten metal when moulding, or, in other words, the more lime or alkali present, the more easily the sand is converted into slag.

Alumina is the binder, hence a sand high in alumina is said to be strong or possess "bond"; alumina is very refractory, but, unlike silica, it bakes together like pottery at a high temperature, consequently too much alumina must not be present in sand, otherwise the mould would be spoiled by excessive shrinkage or by the sand being non-porous.

Lime may exist in sand as oxide, hydrate, carbonate or sulphate, occasionally in two different forms, but usually as carbonate and oxide; the carbonate is the most objectionable form, as, on heating, the carbonic acid gas is driven off, producing an excess of gas and reducing the original volume of sand. Most of the lime salts are converted into oxide on burning, consequently excess of lime will cause a mould to either drop or crumble.

Iron may be present as ferrous oxide, ferric oxide, hydroxide, or as ferrous carbonate, all of which are converted into ferric oxide by heat. Iron in the presence of silica, alumina, lime, magnesia, etc., has a tendency to fuse or produce a slag by reduction.

Manganese in sand acts in a similar manner to iron, but not in such an energetic manner on account of its high fusion point.

Magnesia is very similar to lime, but less harmful on account of being more refractory.

Organic matter gives bond to sand, but the bond or binding properties are destroyed the moment it comes in contact with molten metal, the organic matter being burned out; consequently there is a loss in volume, and this shrinkage causes the sand to fall or crumble.

Combined water is always present in high-alumina sands, and is one reason for the shrinkage in a strong bonded sand.

The sand purchased under this specification must be within the specified limits in regard to iron, lime and organic matter.

In buying sand, particular attention will be paid to the degree of fineness. The sand will be designated by number, and must correspond to the proper degree of fineness; thus, for example, if a No. 3 moulding sand is ordered, the degree of fineness must be between 75 and 90 per cent.

This specification, whilst leaving much to be desired, clearly shows that the American foundryman is working in the right direction in creating sand tests which enable him to express his requirements of a sand to either the mine or mill, and one cannot under-estimate our indebtedness to Outerbridge, C. Powell, Karr, Lane, Hanley and Harrington, Melcher, Wolff and Grubb and Moldenke, all of America; and also Boswell and Holmes of this country, who have made a concentrated study of the subject. Sand standardisation, however, even in America is still a long way

off, due no doubt to the fact that a different combination of properties is not only required for each of the various classes of alloys, but often for particular type of castings in any specific alloy.

An attempt to formulate the essential qualities and requirements of moulding sands for light alloys, brass, bronze, cast iron and steel in their relative order of importance is given in Table II.:—

TABLE II.—*Requirments of Moulding Sand for Various Alloys.*

Al and its Alloys.	Brass.	Bronze.	Cast Iron.	Steel.
Bond	Bond	Texture	Bond	Refractoriness
Texture	Texture	Bond	Permeability	Water content
Water content	Refractoriness	Heat conductivity	Refractoriness	Heat conductivity
Permeability	Longevity	Longevity	Texture	Bond
Heat conductivity	Water content	Permeability	Longevity	Permeability
Longevity	Permeability	Refractoriness	Heat conductivity	Texture
Refractoriness	Heat conductivity	Water content	Water content	Longevity

Whilst neither *chemical nor mineral analysis* is included in these tests, it is not implied that these have no value. They are, however, quite unnecessary to the foundryman at the present time. In fact, as will be shown later, the above-mentioned tests may be reduced considerably, and simplified to such an extent that the scientific control of the essential properties of the daily sand mixture is possible in the most humble foundry, which *does not* possess a laboratory.

TESTING OF MOULDING SANDS.

Strength of Bond.

This is a measure of the cohesion of the sand particles after pressing together in either the green state or after baking. The chemistry of the bond, *i.e.*, of the material responsible for holding the particles together, is little understood, and is complicated by such physical factors as form and size of sand particles, surface-tension effect, water content, etc., meriting a discussion beyond the scope of this present Paper.

Green Sand.

In the green state the author has found the dropping test to be of real value. The sand is gently rammed up in a skeleton core box 8 in. × 1 in. × 1 in. on a sheet of plate glass ¾ in. section. The ends of the box are then removed, and the test-piece pushed carefully along over the edge of the glass until it collapses. The length remaining, measured from the middle, subtracted from the original length, is recorded as a measure of the bond. The average of two tests must be taken. With a weak sand this will be from 2 to 2½ in., with a strong sand from 3 to 3½ in. If over 3½ in. is obtained the sand is too tough, and will be accompanied by a low permeability figure, a common cause of blown and buckled castings.

Dry Sand and Loam.

The bonding strength may be measured by the tensile compression or transverse test. For the tensile test, the standard tensile cement-mould is satisfactory. For the compression test, a 1-in. cube is suitable, moulding this separately or cutting from one-half of the transverse test-piece. The transverse test-bar is made in the same box as that used for the green-sand test. Each test-piece is then dried and baked at 400 deg. F. (205 deg. C.) for two hours, and broken over 4 in. centres.

After an extensive investigation into the relative values of these three tests, the value of the transverse test should be particularly emphasised, as furnishing all desired information necessary so far as strength is concerned.

One-half of the broken transverse bar provides a useful form for a rubbing test, to determine the resistance offered by particles of sand to the wash of the metal.

Texture of Grain Size.

The quantitative determination of the various grains which constitute a moulding sand is of fundamental importance, and has been the subject of detailed investigation on the part of Scranton, Boswell, Crooks, Parmelee, Stokes, etc. For practical foundry purposes a set of sieves, including a number 20, 30, 60, 90, 100, 120, and 200, with punched round holes, is all that is required, fitting one into another in the order stated. After drying the sand at 230 deg. F. (105 deg. C.), and gently disintegrating with the fingers, 200 grammes are weighed out and placed in the No. 20 sieve. The whole is then carefully sieved through to the 200-mesh sieve, recording the percentage by weight retained in each. There are many technical objections against this method, but it supplies all the information necessary to the purchase and use of a sand, viz., the relative quantity of sand and clay, porosity or openness, refractoriness and heat conductivity.

Heat Conductivity.

In dry sand and loam moulds heat conductivity is closely associated with grain size and the *pressure applied* in ramming. Without doubt, the smaller the grain and the more compactly rammed, the more rapid is the extraction of heat from the metal. It is a property on which little systematic investigation has been published.

Refractoriness.

This is best determined by heating 5 grs. in an electric carbon-resistance tube furnace for 30 mins. at 1,200 deg. C., and then examining under a hand-glass or low-powered microscope. Sands showing any signs of fusion or fritting should be rejected as unsuitable for steel and cast iron. With brass, bronze and Al this test is not so important, although it is essential that the fluxing action of these alloys receives due consideration.

Permeability.

This is the property of allowing gases to pass through the pore spaces. It must not be confused with openness, a property clearly associated with porosity—a measure of the actual quantity of pore spaces—a subject fully dealt with by F. Melcher, Proc., Institute of Mining and Metallurgical Engineers, April, 1920.

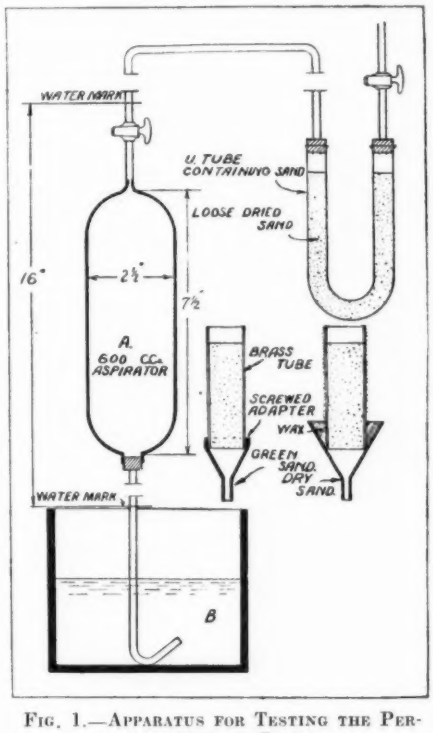


FIG. 1.—APPARATUS FOR TESTING THE PERMEABILITY OF SANDS.

Various methods have been suggested to measure permeability. Karr, "Iron Age," September 30, 1920, Wolff & Grubb. A.M.I.M. and M., October, 1920, detail useful types of apparati. Simplicity of operation and concordant results from various operators are the essential requirements of *any* apparatus. Fig. 1 shows diagrammatically the apparatus used for the sands tested in this particular research.

The principle of the apparatus is to determine the time in seconds to draw a known quantity of air through a unit mass of sand.

A is a copper vessel, rigidly fixed in a suitable clamp open at both ends, with a cock attached at the top. Secured to the lower end by means of a rubber tube is a bent glass tube, of the form and dimensions shown. This dips into a jar of water of known capacity. The sand may be tested either in the loose or rammed state. To test loose a metal tube is used. The sand, which has been dried previously at 220 deg. F. (105 deg. C.) is poured into it, gently tapping the sides of the tube while the sand runs in. This must be performed so that each sand receives the same treatment. After filling the copper vessel A with water by drawing from B, the sand test-tube is connected by means of a rubber tube. The time to empty A in seconds is recorded as the "permeability figure."

Green Sand.

The permeability test of green sand is a somewhat delicate operation, and the apparatus employed in this research, though reliable and rendering good service, still leaves something to be desired. It is the outcome of continuous laboratory experiments conducted in conjunction with actual casting tests. Calibration of the apparatus extended over a long period of time and concordant results are obtained by different operators. Full details of the apparatus are shown diagrammatically by Fig. 2. A is a steel base plate. Into this is screwed brass tube B, on the top of which a slotted brass ring is placed. The sand is gently rammed into this tube by means of a ⅜-in. wood rod in the ordinary way to ½ in. from the top. Into this is placed the stem of plate C.

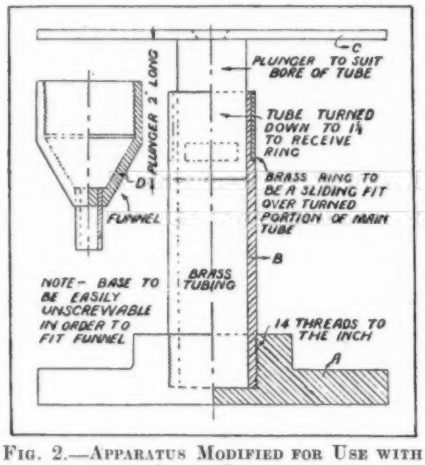

C
PLUNGER TO SUIT BORE OF TUBE
PLUNGER 2" LONG
TUBE TURNED DOWN TO 1⅛ TO RECEIVE RING
BRASS RING TO BE A SLIDING FIT OVER TURNED PORTION OF MAIN TUBE
D
FUNNEL
B
BRASS TUBING
NOTE- BASE TO BE EASILY UNSCREWABLE IN ORDER TO FIT FUNNEL
14 THREADS TO THE INCH
A

Fig. 2.—Apparatus Modified for Use with Green Sand.

Pressure is then applied, compressing as required. In the early stages of development of this apparatus the pressure was applied by means of a delicate lever mechanism to a predetermined cone density test. After considerable experimental work, it was found possible to simplify the test by applying a pressure of exactly 60 lbs. and rotating six times. The weight removed, top plate C is withdrawn, the brass ring lifted away, and by the aid of a spatula the sand above the top of the slot is cut away. The brass tube containing the sand is removed from the base-plate, and screwed into a cone-shaped adaptor D, which is attached to the aspirator A (Fig. 1) by means of a stout rubber tube. The time taken to empty A (Fig. 1) in seconds is recorded as the "permeability figure."

Dry Sand and Loam.

The test-piece used for dry sand and loam is 2½ in. long × 1 in. dia. This is moulded in a suitable core box, air dried, gently heated to 400 deg. F. (205 deg. C.) and baked for 2 hrs. at this temperature. When cool, it is immersed in a mixture of stearic acid and paraffin wax, just molten. Two rapid immersions are recommended, allowing the first to harden before dipping a second time. Should the molten wax be overheated, or the test-piece allowed to remain in the wax too long, it will percolate the test-piece. When the second coat has set hard the bottom ¼ in. is cut off with a pocket knife. The test piece is then set in a glass funnel with plastic wax and molten wax run in. When firmly set the top of the test-piece is cut open with a specially shaped tool. The funnel is connected to the aspirator and the permeability figure determined in the manner previously outlined.

Water Content.

Uncombined water is determined on 10 grs., drying 4 hrs. at 110 deg. C.

Gas Content.

This is actually the loss on ignition of the dried sand by heating 5 grs. in a platinum crucible at 1,100 deg. C. 4 hrs.

(To be continued.)

"Moulders" of the Industry.

No. 4.—MR. W. H. MEADOWCROFT.

Mr. Meadowcroft is a native of Oldham. He commenced his foundry career at the age of ten with a firm of engineers at Hollinwood, Lancs. At the age of twenty-four he was appointed foreman, and since then has had extensive experience at home and abroad. Mr. Meadowcroft was one of the early experimenters with semi-steel, and still retains a great belief in the future of this

Mr. W. H. Meadowcroft.

material. He is well known as a keen advocate of better working conditions in the foundry. He has made special study of core and mould-drying problems. He was elected President of the Lancashire Branch of I.B.F. 1921-22, and has given many Papers on various practical subjects before this Branch.

Mr. Meadowcroft is now foundry manager to Messrs. John Grundy, Limited, drying and general engineers, of Tyldesley, Lancs.

Overseas Trade Advisory Committee.

The Parliamentary Secretary to the Department of Overseas Trade has appointed some additional members to his Advisory Committee. The membership of the Committee now includes the following gentlemen associated with the metallurgical industries: Mr. Arthur Balfour, J.P., of Sheffield; Sir William Ellis, G.B.E., of Sheffield; Sir Algernon Firth, Bart., late chairman of Messrs. T. Firth & Sons, Limited; Mr. W. L. Hichens, of Sheffield; Mr. F. Hickinbotham, of Birmingham; and Sir William Larke, K.B.E.

An Apprenticeship Course in Foundry Practice.—XLV.

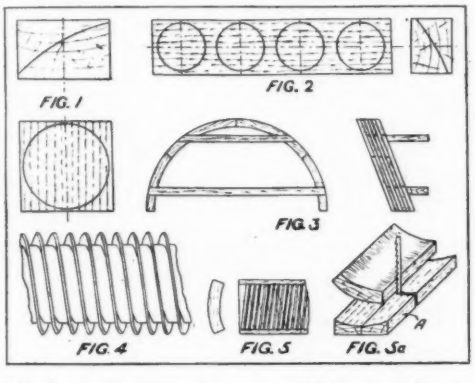
By Ben Shaw and James Edgar.

PATTERN-MAKING MACHINES.—II.

There is a large difference between being, what may be termed, a machine attendant and a machine operator. A man may have a first-class knowledge of sharpening planer knives and circular and bandsaws, and yet be of little use as a machine operator. On the other hand, good operators are not invariably experienced in adjusting the machines. Because a shape is irregular the apprentice must not at once decide that it cannot be cut at a machine. He should rather believe that a circular or bandsaw will cut any shape except concave surfaces. The first consideration when a block of timber has to be carved, is how much of the work can be done on the machines. Sometimes awkward shapes can be sawn with a little ingenuity and without the use of jigs; at other times it is profitable to make a really elaborate jig.

Bosses Fitting on Cylinders.

Figs. 1 and 2 illustrate examples of work that can be quickly made without jigs. Fig. 1 is a circular boss which has to fit a cylinder at some distance from the longitudinal centre line. An unmethodical craftsman would prepare a parallel piece of timber and finish it to a diameter, afterwards fitting it in a haphazard way to the



cylinder. The proper way would be to plane a piece of timber square, draw the fitting curve on the ends and the diameter on top. The fitting shape would then be cut at the bandsaw almost to the line, after which the two pieces would be temporarily fastened with sprigs and the diameter sawn and sandpapered or chiselled. With care, such a boss should require very little fitting.

Fig. 2 is similar to Fig. 1, but in this case four bosses are required. It would, of course, be possible to make four separate pieces of wood, but it is much simpler to prepare one long piece of timber More risk is involved in sawing this, but if the saw is sharp, it should be possible to get a square cut.

Segmental Ring at Angle.

The two examples just considered are comparatively simple, but Fig. 3 illustrates a much more difficult bandsaw job. This is a ring inclined at an angle. Assuming that it is 5 ft. dia. and $\frac{7}{8}$-in. thick, and that it is a distance of 16 in. off the square. A couple of pieces of wood would be attached to the half ring to give the desired bevel, these being sufficiently close together to ensure them both being on the saw table while the ring was being cut. The outside would be sawn to leave just sufficient to clean off on a sand-papering disc. The pieces of wood would then be removed and the correct thickness gauged from the outside. The sawing out of the inside would be a more difficult proposition, but it could quite satisfactorily be accomplished by sawing to the line shown on one side, with the flat ring upon the table, assistance being obtained to lower and raise the table while sawing to the line on the reverse side. By adopting this method the fragile ring would have the support of the table in both cases. It would be possible, of course, to use the timber supports even when sawing the inside, but it would be exceedingly awkward and difficult to do so. It would be necessary, after sawing it to the narrow strip, to withdraw the work from the bandsaw, unfasten the strip, replace the work on the table and then screw the strip back into its former position, after which a saw cut could be made up to the wide strip. There would be imminent danger of straining the bandsaw if this method were adopted, and there would not be sufficient gain on the first method described to make it really profitable.

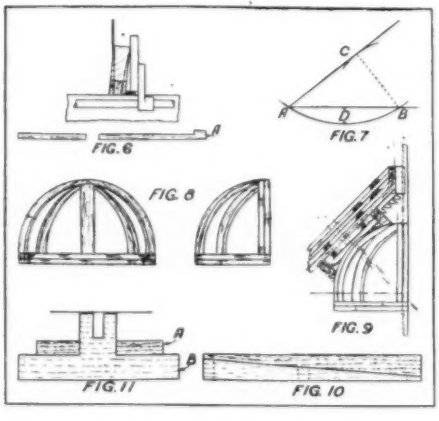
Conveyor Screw.

Fig. 4 shows a portion of a conveyor which would present very great difficulty to a craftsman unable to make the greatest use of the machines. It would be both a laborious and a costly piece of work to make entirely by hand methods. The thread of this conveyor is about 3 in. deep, the thickness tapering from $\frac{3}{8}$-in. at the base or root, to 5/16-in. at the point. A method of meeting the difficulty of construction is shown in the sketch Fig. 5. The pattern-maker would first prepare a drum or barrel equal in diameter to the base of the threads, upon which he would mark the helical curve, so that the threads would be fixed in the correct positions. For such a job it would be advisable to get the thickest possible timber for the threads. With the aid of the bandsaw a number of segments would have to be cut as deep as the material would allow, having the grain of the timber running as near as possible to the angle of the threads shown on the left of Fig. 5. The length of the helix for one revolution would be divided into, say 8 parts, to obtain the length of the segment required. A jig A (Fig. 5a) would have to be made, being cut to a radius similar to that for the outside of the threads. This jig would have to be fixed to the saw table with the saw running through the centre of it as shown, and at an angle to the saw equal to the angle formed by the thread. This angle could be obtained by using the circumference of the outside of the thread as a base, and the lead of the screw as the height, thus forming a triangle, the angle formed with the base being the angle required. The saw table would have to be slightly bevelled to allow for the small amount of taper on the thread. The segmental pieces would be marked to provide as many portions of the thread as possible, at the same time giving clearance for the saw. The sketch on the right of Fig. 5, shows the method of moving the segmental portion on the jig A, sawing from each side alternately to give the required taper. These pieces could be cut so accurately that no tool finishing would be necessary, and after sandpapering they could be secured to the cylindrical drum previously prepared.

Lagging.

A form of lagging which is common in pattern-making is that for globe valves, in which timber $2\frac{1}{2}$ in. thick is tapered on each side and cut on the outside to the shape of the globe, after which, in order to reduce weight or save timber, it is gauged to a parallel width. To make this lagging, careful handling is necessary at the circular saw. Two templates would first be made, one of these corresponding to the longitudinal shape of the lag, and the other to the end shape. The bandsaw would be used for cutting the inside and outside shapes, the outside being left about $\frac{1}{4}$-in. larger than the finished size to allow for turning. A large ripping circular-saw would most satisfactory bevel each piece. The usual type of saw installed in patternshops is not provided with an adjustable fence, hence an improvised arrangement would be necessary to suit the required bevel. Fig. 6 shows very clearly a suitable arrangement. The piece A has a shouldered end which, coming into contact with the end of the fence, acts as a stop.

Another form of lagging which is even more common in pattern-making is that about 1¼ in. or 1½ in. thick and 4 in. or more wide, for plain cylindrical bodies. To prepare the lags in the definite lengths and possessing the necessary bevel is, of course, a comparatively easy matter on the average dimension saw so designed that the table can be adjusted to any reasonable angle. The problem, however, which gives most trouble is that of making the concavity of the lags approximate to the desired curve. Many pattern-makers get a temporary fence into correct position by trial, and frequently destroy one of the lags in doing so. The most accurate and methodical way is to make use of a simple geometrical principle. It is only on very rare occasions indeed that the diameter of the saw will be similar to the diameter of the ground. As is well known, cylindrical bodies cut at any angle other than a right-angle, produce the outline of a true ellipse, therefore if the fence of the saw is set at an angle other than a right-angle, it is impossible to obtain the correct curve. A practical method of obtaining the correct angle of the fence which will give the curve most near to the curve required, within the limits of the saw diameter, is illustrated by Fig. 7. It is first



necessary to describe an arc equal in diameter to the saw. The chord AB should then be drawn, the height D being equal to the depth of the required cut. The arc BC should be described with point B as centre and the line AC drawn touching this arc at C. CAB is the correct angle for the fence. When it is necessary to make a very deep cut, it may be advisable to rough out a portion of the timber at the dimension saw with the fence set at an angle.

Bevel Wheel Teeth.

Many methods are in use for making bevel wheels. We do not propose in this article to go over these various methods, but simply to show how the teeth of a bevel wheel can be very conveniently cut on a bandsaw. The method is suitable for small bevel wheels that are shaped from a solid block of timber, and it is equally suitable for large bevel wheels, which are segmentally built with the teeth glued in separately as shown in Fig. 9. This is one of the most ingenious and least used jigs in pattern-making practice, and the principle upon which it depends is not applicable to any other class of work but bevel wheels. The jig really consists of a semi-spherical construction on which a saddle fits. This saddle can be moved over the spherical surface, and if the bevel wheel block is screwed to it, the teeth can be sawn accurately to shape, because every line sawn, while the shoe is free to move over the sphere, is radial. It is really only necessary to mark out the teeth at the large end, although the apprentice would be well advised to mark them out at both ends as carefully as though he was going to cut them with a gouge and chisel at the bench. If care is taken and a sharp saw is used, very little hand finishing should be necessary. Fig. 8 shows a suitable construction for large wheels, but a sphere for small wheels can be turned from solid timber, and the shoe which is shown as of segmental construction in Fig. 9 can also be turned from the solid. Even when it is built, it is advisable to turn it on the face plate, a template being used for the concave fitting shape.

Planing Machine Jigs.

Craftsmen who are very ingenious in devising jigs for the various machine saws and sandpapering machines, seldom realise how much can be done in this respect at the planing machines. Twenty years ago, not many patternshops had even a surfacing machine, and to-day there are many comparatively large shops which have either a surfacing machine or a thicknessing machine, but not both. When there is a choice between finishing timber on the saw or on the planing machine, the planing machine is always preferable because the work is then quite finished. With a planing machine, in proper order and with good adjustment, it should not be necessary, unless in very exceptional cases, to touch the timber afterwards at the bench. Many jigs can be devised for planing timber at an angle, either longitudinally or crosswise. Assuming that it is required to plane a length of timber from ½ in. at one end to 2½ in at the other end. In order to save material the experienced craftsman would saw the surplus off at the circular saw, leaving only ⅛-in. or so to be planed. In Fig. 10 the dotted lines indicate pieces which could be screwed to the board, the distance between these pieces being such that two of them would always be on the table between the knives and the end rollers. The shorter the distances between, the less risk there would be of sagging. If several tapered boards were required, the first board planed would serve the purpose of a table for the remaining boards, as shown at Fig. 10. For cross-bevelling of timber a similar method could be employed for the first piece, which could also be used as a table for the remaining pieces.

Planing Thin Timber.

It is sometimes necessary to plane timber 1/16-in. thick. It is quite impossible to plane this thickness in the ordinary way and the practical method is, in the first place, to plane a thick board to a parallel thickness and use this as a moving table, the thin timber resting on top of it. If care is exercised it should be possible to plane large surfaces in this way and without any roller marks being left.

When making barrels, it is a great time-saver, if there is no surfacing machine at which the edges of the lags can be bevelled, to rig up a simple jig, which enables one to plane the lags to the correct bevel and width between the tables of the thicknessing machine. As with the circular and bandsaws it is quite impossible to attempt to describe the almost innumerable devices for finishing timber, but with the examples given, the apprentice should have no difficulty in adapting them to suit various purposes.

Sander Jig.

Short pieces of timber, when they are very narrow and thin, can often be more satisfactorily finished at the sandpapering machine than at the trimmers with the aid of a jig. Fig. 11 shows one form of jig which is suitable for this purpose. AA are stops which are fastened to the machine table, and B is a guide piece, with the slot into which the required pieces are dropped. If these pieces have first been sawn at the band or circular saw to about 1/32-in. longer than required, a touch on the sandpaper is sufficient to finish them. Sometimes it is advisable to make a guide piece with several slots if a large number of parts are required. Let it be clearly understood, however, that very little must be removed by the sandpaper, because end grain is very destructive, and there is good reason for the rule in some patternshops that end grain blocks must not be finished at this machine. The trimming machine is the proper machine for this purpose, but it may be excusable, when strips of timber ⅛ to ¼-in sq. are required in large quantities.

Compañia Española de Minas del Riff.—The shareholders of this Spanish concern, owning iron mines in North Africa, have approved of the proposal to distribute further 50 pes. per share for the financial year 1922, which, with the 50 pes. already paid, represents a dividend of 10 per cent. free of tax.

Linear Contraction of a Series of Brasses and Bronzes.*

By Robert J. Anderson and Everett G. Fahlman.

This paper is issued as a contribution to the literature of non-ferrous alloy foundry practice, and is based on an investigation carried out by the Bureau of Mines in connection with its non-ferrous metallurgical work. Experiments were carried out for the purpose of determining the linear contraction of a series of brass and bronze alloys on casting into sand moulds with a view to obtaining data to be used for making pattern allowances in the production of non-ferrous alloy castings. As is well known, a considerable variety of copper alloys, including ordinary bronzes, phosphor bronzes, zinc bronzes, lead bronzes, lead-zinc bronzes, red brass, yellow brass and others, are employed for castings in non-ferrous foundry practice.

The usual figure employed for the pattern-maker's shrinkage allowance in the case of these copper alloys is taken as about 3-16 in. per foot, equivalent to 0.188 in. per foot, or 1.57 per cent. In reviewing the literature, it was found that there was a dearth of reported measurements of the linear contraction of non-ferrous alloys although much work had been done, and many of the results reported, in the case of cast iron by Keep, West, and other early workers in the cast-iron foundry field. The roughly approximate figure given above for the linear contraction of copper-casting alloys is entirely too poor for good pattern work, and it is desirable to point out that it is good practice to determine the contraction of every alloy poured in the foundry, under a variety of definite conditions, and to make the pattern allowances accordingly. Of course, ordinarily, larger allowances than those indicated are employed in the case of manganese brass, monel metal, aluminium bronze, and other "high shrinkage" alloys.

So far as is known, no systematic study of the linear contraction of the commercial casting alloys of the brass and bronze type has been reported, although some papers have appeared dealing with the contraction of alloys embraced in a given binary system, for example, copper-zinc alloys, aluminium-zinc alloys, copper-tin alloys, and others. It is hoped, therefore, that the data given in the present paper will be found of interest to the non-ferrous foundry industry. In the case of 21 alloys examined in the investigation reported here, the linear contraction on pouring bars into sand moulds was found to vary roughly between 1.1 and 2.2 per cent. Of course, the linear contraction is a function of the chemical composition of the alloy, the type of mould used, the pouring temperature, size of section, method of gating, and other factors. Obviously, in pattern work, the proper value for contraction should be employed, and the pattern allowance to be made can be determined by making contraction measurements for the different alloys over a range of pouring temperatures and size of section. In the present paper figures are given for the linear contraction of a series of 21 copper alloys of the brass and bronze type on pouring into sand moulds under definite conditions.

Object and Scope of Experiments.

The object of the investigation reported here was to determine the linear contraction of a series of brass and bronze alloys used generally in foundry work. The number of alloys was limited to 21, but these include the principal alloys employed to-day in non-ferrous foundry practice. It was desirable to extend the investigation considerably so as to include a number of other alloys and to examine the effect of varying percentages of impurities upon the contraction of the ordinary alloys, but time was not available for so extending the investigation. Measurements were made of the linear contraction of the 21 selected alloys on pouring into sand moulds at two different temperatures (a high pouring temperature and a low pouring temperature) and in two different size cross sections of bars ($\frac{1}{2}$-in. square and 1-in. square). The method of the investigation consisted in measuring the linear contraction of the alloys on casting into sand moulds between the faces of cast-iron templates. The faces of the templates were 12.000 ins. apart, and the details of the method of experiment are discussed in a later section of this paper.

General Information and Previous Work.

Not many data are available in the literature relating to the linear contraction of brass and bronze alloys on pouring into moulds, but a summary of the available data and a guide to the literature have been given in papers by one of the writers. It may be pointed out that the bulk of the reported work, in the case of data for the contraction of non-ferrous alloys, has been carried out by Turner and his students in connection with studies with the Turner extensometer. For the purpose of the present paper, the linear contraction of a metal or alloy may be taken as the diminution of length which takes place on cooling in a mould, and the terms linear contraction and pattern-maker's shrinkage are synonymous. Turner states that the shrinkage may be defined as the difference between the length of a casting and that of the pattern from which it was produced, *i.e.*, it is the difference in volume between the fluid metal in the mould and the resultant casting at the ordinary temperature. In experimental measurements, the linear contraction may be most readily determined by measuring the diminution in length of a bar cast from a pattern of definite length. The linear contraction may be expressed in percentage diminution in length, in inch per foot, or in terms of the pattern-maker's shrinkage scale.

Full discussion of the technical aspects of the contraction problem need not be included here, since that has been given in other papers by one of the writers, but it is of interest to include a short review of work by other investigators. As is well known, Keep has described an apparatus for measuring the contraction of cast iron, as has West, and the methods of these investigators have been applied in determining the contraction of the non-ferrous alloys. Turner and Murray have studied the cooling changes occurring in the copper-zinc series of alloys, using the Turner extensometer, and have reported many figures. Thus, for 70 : 30 brass, these investigators obtained the

TABLE I.

Pattern-maker's Shrinkage Allowance of Non-Ferrous Alloys.†

Nominal composition of the alloys, elements, per cent.								Pattern-maker's shrinkage in. per ft.
Cu	Sn	Zn	Pb	P	Al	Fe	Mn	
10.0	—	86.0	—	—	4.0	—	—	1/8
80.0	20.0	—	—	*	—	—	—	1/8
84.0	16.0	—	—	*	—	—	—	1/8
90.0	10.0	—	—	*	—	—	—	3/16
88.0	10.0	2.0	—	—	—	—	—	3/16
86.0	9.5	2.0	2.5	—	—	—	—	3/16
86.0	12.0	1.5	0.5	—	—	—	—	3/16
80.0	10.0	—	10.0	*	—	—	—	3/16
79.5	12.0	—	7.5	1.0	—	—	—	3/16
85.0	5.0	5.0	5.0	—	—	—	—	3/16
78.0	8.0	—	14.0	*	—	—	—	3/16
93.5	6.5	—	—	*	—	—	—	3/16
99.8	—	—	—	—	—	—	—	7/32
57.0	0.75	40.0	—	—	0.5	1.0	0.25	7/32
83.0	6.0	2.0	9.0	—	—	—	—	3/16
90.0	—	—	—	—	10.0	—	—	7/32
89.0	—	—	—	—	10.0	1.0	—	7/32
90.0	6.5	2.0	1.5	—	—	—	—	3/16
88.5	11.0	—	0.25	0.25	—	—	—	3/16
87.25	11.0	—	1.5	0.25	—	—	—	3/16

† Based on Lumen Bearing Co.
* Deoxidised with phosphorus.

* A Paper read before the Cleveland Meeting of the A.F.A., by permission of the Director, U.S. Bureau of Mines.

value 0.202 in. per ft. for the contraction, in the case of ½-in. square bars poured in sand. For 60 : 40 brass, they obtained 0.178 in. per ft. In another paper, Haughton and Turner discuss the contraction of alloys in the copper-tin system. Just recently, Johnson and Jones have described a new form of apparatus for determining the contraction of alloys and have presented figures as to the contraction of the copper-zinc alloys.

Many data as to the contraction of copper casting alloys and the allowance to be made for the contraction when constructing patterns are given in hand books and in trade literature, and attention may be directed to the figures published just recently by the Lumen Bearing Company* in its useful handbook on non-ferrous alloys. Table I. gives a summary of contraction data taken from this handbook. It will be noticed that the pattern allowance is not much different for the different alloys. It should again be emphasised that the contraction of any alloy is dependent upon a number of factors, of which the size of section and temperature of pouring are doubtless the more important. Turning now to a discussion of the work carried out in the investigation reported here, the method of experiment employed and the results obtained are taken up in the following paragraphs.

Alloys Examined for Contraction.

The various alloys employed in the experimental measurements were made up in the foundry from primary commercial metals, and Table II. gives the nominal and actual compositions of the alloys employed. The alloys were prepared by making fixed additions of various metals to copper, and some scrap alloys, *i.e.*, gates and risers from previous melts, were employed in making up succeeding alloys in the series. In selecting the alloys for contraction measurements, it was the aim to include the more common brass and bronze alloys used in foundry practice, and some special alloys were also examined.

While it was desirable to extend greatly the number of alloys and to include testing the effect of pouring temperature and size of section on the contraction over a wide range with the time available it was necessary to limit the work to the alloys chosen and to pouring at high and low temperature and in two sizes of section.

Method of Experiment.

As has been pointed out above, the linear contraction of any alloy on pouring into a mould is dependent upon a number of factors including the pouring temperature, size of test-bar section, and method of moulding (size of gates, whether risers are used, etc.). It was not possible to examine the effects of a number of factors on the contraction of the alloys, but examination was made of the effect of varying the size of section and the pouring temperature. In the experimental measurements made, bars were cast in sand moulds, in the various alloys, from wooden patterns ½-in. sq. by 12 in. long and 1 in. sq. by 12 in. long. The alloys were cast at two temperatures; viz., a high pouring temperature and a low pouring temperature. Thus, the effects of size of section and pouring temperature on the contraction of the alloys were examined.

The attempt was first made to pour the alloys at a definite number of degrees above the liquidus in all cases, but this was not possible because the melting points of certain of the alloys were not known with certainty. In other cases, the alloys became too sluggish at low temperature to permit proper pouring, or else the castings became cold shut at a low pouring temperature which seemed sufficiently high for pouring. In the case of certain of the zinc-containing alloys, it was not possible to pour at too high temperature because of loss of zinc due to volatilisation. The differences between the high and low pouring temperatures for the different alloys varied considerably—from about 100 to 200 deg. C.

The alloys were melted in a pit coal-fired furnace, using a graphite-clay crucible as the containing vessel. Melting and pouring temperatures were taken with a platinum, platinum-rhodium thermocouple, and the pouring temperatures as given are accurate to 2 deg. C. In casting the bars, a heat was brought up to slightly above the desired pouring temperature, and then poured at the required temperature. All conditions of moulding were held as constant as possible throughout the work.

TABLE II.—*Chemical composition of the brasses and bronzes employed in the experiments.**

Name of alloy.	Number of alloy.	Nominal composition.	Chemical composition, elements, per cent.								
			Cu.	Sn.	Zn.	Pb.	P.	Ni.	Mn.	Fe.	Al.
Bronze	1	90:10 Cu-Sn	90.00	10.00	—	—	—	—	—	—	—
Bronze	2	85:15 Cu-Sn	84.22	15.78	—	—	—	—	—	—	—
Bronze	3	80:20 Cu-Sn	79.57	20.43	—	—	—	—	—	—	—
Phosphor bronze	4	89.8:10:0.2 Cu-Sn-P	79.69	10.04	—	—	0.25	—	—	—	—
Phosphor bronze	5	89.5:10:0.5 Cu-Sn-P	89.03	10.44	—	—	0.52	—	—	—	—
Zinc bronze ..	6	88:8:4 Cu-Sn-Zn	88.02	8.37	3.61	—	—	—	—	—	—
Zinc bronze ..	7	88:10:2 Cu-Sn-Zn	87.78	10.46	1.76	—	—	—	—	—	—
Zinc bronze ..	8	86:11:3 Cu-Sn-Zn	87.24	10.77	1.99	—	—	—	—	—	—
Zinc bronze ..	9	84:11:5 Cu-Sn-Zn	84.98	11.15	3.87	—	—	—	—	—	—
Lead-zinc-bronze	10	90:6.3:1 Cu-Sn-Zn-Pb.	89.73	6.51	2.77	0.99	—	—	—	—	—
Lead-zinc-bronze	11	87:7.5:1 Cu-Sn-Zn-Pb.	86.72	7.42	4.75	1.11	—	—	—	—	—
Lead-zinc-bronze	12	84:10.5:1 Cu-Sn-Zn-Pb ..	84,36	9.93	4.72	0.99	—	—	—	—	—
Lead-zinc-bronze	13	76:7:4:13 Cu-Sn-Zn-Pb ..	75,60	6.96	3.92	13.52	—	—	—	—	—
Lead-zinc-bronze	14	85:5:5:5 Cu-Sn-Zn-Pb	85.33	5.48	4.07	5.00	0.12	—	—	—	—
Lead bronze ..	15	80:10:10 Cu-Sn-Pb	78.55	10.81	—	10.48	0.13	—	—	—	—
Alpha brass ..	16	70:30 Cu-Zn	71.20	—	28.80	—	—	—	—	—	—
Tin brass ..	17	70:29:1 Cu-Zn-Sn	70.40	1.30	28.30	—	—	—	—	—	—
Muntz metal ..	18	60:40 Cu-Zn	61.14	—	38,86	—	—	—	—	—	—
Tin muntz metal	19	60:38:2 Cu-Zn-Sn	61.11	2.21	36.68	—	—	—	—	—	—
Nickel bronze ..	20	86:4:6:3:1 Cu-Ni-Sn-Zn-Pb ..	85,30	6.56	3.03	0.77	—	4.34	—	—	—
Manganese brass	21	56:40:1:1.5:1.5 Cu-Zn-Fe-Al-Mn.	56.52	—	39.73	—	—	—	1.24	0.91	1.60

* Analyses by G. B. Dalrymple.

Bars of the sizes mentioned were poured in sand moulds between the faces of a cast-iron template, and the lengths were measured when the bars had cooled to the ordinary temperature. The template was 12.000 ins. between the faces and of the form shown in Fig. 1. The method of moulding is shown in detail in the sketch of Fig. 2.

In moulding, the bar patterns and the templates were moulded together in the drag on the parting line with the cope, the 1-in. bar and ½-in. bar being moulded together in a flask as shown in Fig. 2.

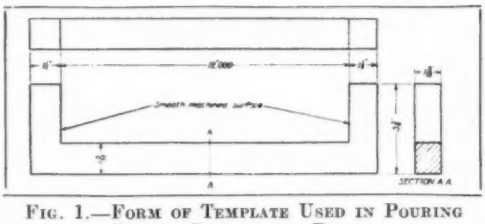


FIG. 1.—FORM OF TEMPLATE USED IN POURING LINEAR CONTRACTION BARS.

The patterns were then removed, leaving the templates in place, and the mould was then closed and poured, each bar being poured from a separate riser and from the same pot of alloy. In the case of the ½-in. sq. bars, a small shrink ball was moulded to the runner, while with the 1-in. sq. bar, a fairly heavy ball was used. No risers were

used, but the moulds were properly vented. The alloy was poured into the mould until the pouring gates were just full. Conditions as to the method of moulding were maintained the same for the different alloys, *i.e.*, the same size pouring gate and runner were used, attempt was made to hold the moisture content of the sand approximately the same, and the hardness of ramming was practically the same for all the moulds. In the case of the ½-in. sq. bars, the pouring gate was 2½ in. high and ⅞ in. dia., and the runner was ⅞ in. wide by ⅜ in. thick by 2 in. long. For the 1-in. sq. bars, the pouring gate was 2½ in. high and ⅞ in. dia., and the runner was ⅞ in. wide by ⅜ in. thick by

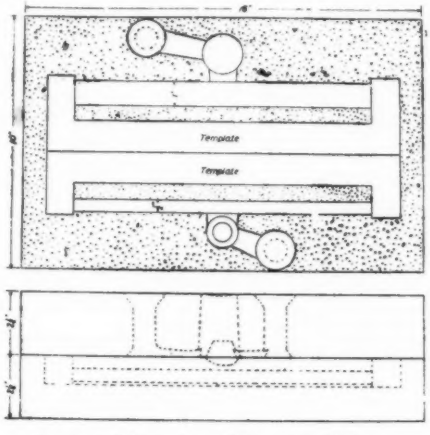


Fig. 2.—Method of Moulding Bars.

2 in. long. The templates were made of grey cast iron machined to size and the same as those employed by one of the writers in experiments on the linear contraction of aluminium alloys. There was found to be no measurable variation in the distance between the faces of different templates or variation in the distances after repeated use. After pouring, the bars were shaken out of the moulds, after cooling for a short time, then cooled in air to room temperature, and measured as to length with a 12-in. vernier caliper.

Table III.

Linear Contraction of the Alloys, Poured at High Temperatures. ½-in. Square Bars.

Alloy No.	Pouring temperature. Deg. cent.	Linear contraction. Inch per foot.	Linear contraction. Pattern maker's scale. Fraction inch per foot.	Range of contraction per cent. between high and low pouring temperatures.
21	1,038	0.261	17/64	2.17 —2.19
18	1,038	0.216	7/32	1.80 —1.89
16	1,093	0.210	7/32	1.75 —1.77
19	1,038	0.203	13/64	1.69 —1.875
17	1,066	0.198	13/64	1.63 —1.67
20	1,260	0.172	11/64	1.43 —1.425
14	1,260	0.171	11/64	1.425—1.47
11	1,232	0.168	11/64	1.40 — —
3	1,204	0.165	11/64	1.375—1.55
13	1,260	0.164	11/64	1.37 —1.37
7	1,288	0.160	5/32	1.33 —1.30
6	1,260	0.160	5/32	1.33 — ..
8	1,260	0.160	5/32	1.33 —1.39
10	1,260	0.160	5/32	1.33 —1.43
12	1,260	0.158	5/32	1.32 —1.35
9	1,260	0.158	5/32	1.32 —1.36
2	1,260	0.157	5/32	1.31 —1.45
4	1,316	0.153	5/32	1.275—1.28
1	1,316	0.153	5/32	1.275—1.30
5	1,316	0.151	5/32	1.275—1.30
5	1,316	0.151	5/32	1.26 — —
15	1,260	0.150	5/32	1.25 —1.31

Results of the Linear Construction Measurements.

Summaries of the measurements made on the linear contraction of the alloys are given in the accompanying Tables III. to VI. inclusive. In the tables, the alloys are arranged in the order of their contraction, and the different tables give data for pouring at high and low temperatures, and for the small and large bars. Table III. gives the linear contraction of the series of alloys, poured at high temperatures, in the case of the ½-in. sq. bars, while Table IV. gives the linear contraction of the alloys, poured at low temperature, for the same size section. The range of contraction for the alloys poured at high temperatures is from 1.25 per cent. for the 80 : 10 : 10 copper-tin-lead alloy to 2.17 per cent. for the manganese brass. The range of contraction for the alloys cast at low temperatures is from 1.28 per cent. for the 89.8 : 10 : 0.2 copper-tin-phosphorus alloy to 2.19 per cent. for the manganese brass.

Table V. gives the linear contraction of the alloys when poured at high temperatures, in the case of 1-in. square bars, while Table VI. gives the contraction of the alloys when poured at low temperatures for the same size section. The range of contraction for the alloys poured at high temperatures is from 1.11 per cent. for the 89.5 : 10 : 0.5 copper-tin-phosphorus alloy to 2.08 per cent. for the manganese brass.

Table IV.

Linear Contraction of the Alloys, Poured at Low Temperatures. ½-in. Square Bars.

Alloy No.	Pouring temperature. Deg. cent.	Linear contraction. Inch per foot.	Linear contraction. Pattern-makers' scale Fraction inch per foot.
21	927	0.263	17/64
18	927	0.227	15/64
19	927	0.225	15/64
16	982	0.212	7/32
17	954	0.200	13/64
3	982	0.186	3/16
11	1.010	—	—
14	1,093	0.176	11/64
6	1,093	—	—
2	1,038	0.174	11/64
10	1,038	0.172	11/64
20	1,149	0.171	11/64
8	1,093	0.167	11/64
13	1,093	0.165	11/64
9	1,093	0.163	11/64
12	1,093	0.162	5/32
15	1,093	0.157	5/32
5	1,093	—	—
7	1,121	0.156	5/32
1	1,093	0.156	5/32
4	1,149	0.154	5/32

Owing to the variable composition of the different alloys, the results do not lend themselves readily to discussion as to the effect of chemical composition of the copper-casting alloys upon their contraction, and the data may properly be regarded as useful in indicating the contraction of different alloys of specific compositions. In Table IV., no data were obtained as to the contraction of three of the alloys at low pouring temperature because of mis-runs.

General Discussion of the Results.

The results of the experimental measurements show that the linear contraction of a series of 21 copper alloys varies from about 1.1 to 2.2 per cent., depending upon a number of factors. These factors include the chemical composition of the alloys, the size of the section poured, the pouring temperature and others. The effects of these factors may be discussed briefly here in the light of the experimental measurements made, but sufficient data are not in hand to warrant drawing definite conclusions. Not enough data are in hand to permit drawing conclusions as to the effect of various additive elements upon the contraction of given alloys. With reference to the effect of the pouring temperature upon the contraction of the alloys; theoretically, the higher the pouring temperature, the greater the contraction since less metal can be put into a mould cavity of a given size at a higher temperature than at a lower one. However, owing to gas occlusion and the evolution of gas on cooling and freezing, pouring at a high temperature may yield less contraction in an alloy than pouring at a lower temperature. In the case of the ½-in.

sq. bars, it is found that of the 21 alloys, pouring at a high temperature resulted in greater contraction than pouring at a low temperature in only two cases, viz., with the 86 : 4 : 6 : 3 : 1 copper-nickel-tin-zinc-lead alloy and the 88 : 10 : 2 copper-tin-zinc alloy. In the case of the 1-in. sq. bars, it is found that of the 21 alloys, pouring at a high temperature resulted in greater contraction in 11 cases. The fact that in the majority of instances less contraction was given in pouring at

TABLE V.

Linear Contraction of the Alloys, Poured at High Temperatures. 1-*in. Square Bars.*

Alloy No.	Pouring temperature. Deg. cent.	Linear contraction. Inch per foot.	Linear contraction. Pattern maker's scale. Fraction inch per foot.	Range of contraction per cent. between high and low pouring temperatures.
21	1,038	0.250	1/4	2.08 —2.18
16	1,093	0.211	7/32	1.76 —1.73
17	1,066	0.202	13/64	1.68 —1.67
18	1,038	0.196	13/64	1.63 —1.90
19	1,038	0.188	3/16	1.57 —1.97
20	1,260	0.172	11/64	1.43 —1.42
10	1,260	0.171	11/64	1.425—1.42
14	1,260	0.169	11/64	1.41 —1.42
3	1,204	0.168	11/64	1.40 —1.53
11	1,232	0.165	11/64	1.375—1.30
9	1,260	0.164	11/64	1.37 —1.27
8	1,260	0.161	5/32	1.34 —1.335
13	1,260	0.161	5/32	1.34 —1.37
12	1,260	0.159	5/32	1.325—1.32
7	1,288	0.156	5/32	1.30 —1.27
6	1,260	0.153	5/32	1.275—1.27
4	1,316	0.153	5/32	1,275—1.23
15	1,260	0.152	5/32	1.27 —1.275
2	1,260	0.152	5/32	1.27 —1.375
1	1,316	0.148	5/32	1.23 —1.275
5	1,516	0.133	9/64	1.14 —1.14

higher temperatures than at lower ones may be explained by the effect of gas occlusion.

In comparing the effect of the size of section upon the contraction, irrespective of the pouring temperature, it is found that in general greater contraction obtains when the alloys are poured in 1-in. bars than in ½-in. bars. This is to be expected on the basis of experience, since in casting practice it is known that thin sections contract less than thick sections. In casting practice, the contraction allowance to be made is dependent upon the mass of the casting, its design, and the relation between the thick and thin sections, so that for the same alloy, different pattern allowances must be made for thick and thin castings. In the experiments reported here, the least contraction of the various alloys was obtained in the case of ½-in. sq. bars poured at high temperatures, while the greatest was given by 1-in. sq. bars poured at low temperatures. In general, it may be said from this that the smaller the size of section and the higher the pouring temperature the less the contraction, and the greater the size of section and the lower the pouring temperature the greater the contraction.

TABLE VI.—*Linear Contraction of the Alloys, Poured a Low Temperatures.* 1-*inch Square Bars.*

Alloy No.	Pouring temperature. Deg. cent.	Linear contraction. Inch per foot.	Linear contraction. Pattern-makers' scale Fraction inch per foot.
21	927	0.262	17/64
19	927	0.236	15/64
18	927	0.228	15/64
16	982	0.208	7/32
17	954	0.200	13/64
3	982	0.184	3/16
10	1,038	0.170	11/64
14	1,093	0.170	11/64
20	1,149	0.170	11/64
2	1,038	0.165	11/64
13	1,093	0.164	11/64
8	1,093	0.160	5/32
12	1,093	0.158	5/32
11	1,010	0.156	5/32
1	1,093	0.153	5/32
7	1,121	0.153	5/32
7	1,121	0.153	5/32
9	1,093	0.153	5/32
6	1,093	0.152	5/32
15	1,093	0.152	5/32
4	1,149	0.148	5/32
5	1,093	2.000	9/64

In passing, it is of interest to refer to the piping of alloys in relation to their linear contraction and contraction in volume on freezing, and the effect of the pouring temperature upon piping (and consequently contraction). Two 1-in. sq. bars of 85 : 5 : 5 : 5 copper-tin-zinc-lead alloy were prepared with the shrink balls attached. The one bar was poured at 1,260 deg. C. and the other at 1,093 deg. C. There was considerable piping in the shrink ball of the second bar, while the upper surface of the ball of the first bar is flat and not piped. This would indicate immediately that the contraction of the bar poured at 1,093 deg. C would be greater than the one poured at 1,260 deg. C., although there was not any appreciable difference, the contraction of the former being 0.170 in. per ft. and that of the latter 0.169 in. per ft. However, it was possible in many instances to find clear relations between the piping shown on the shrink ball and the linear contraction of the alloys.

In summing up the results of the work, it has been found, that :—

(1) The linear contraction of a series of brass and bronze alloys, covering a fairly wide range of composition and including the usual commercial alloys, varies roughly from about 1.1 to 2.2 per cent., depending upon the chemical composition and other factors.

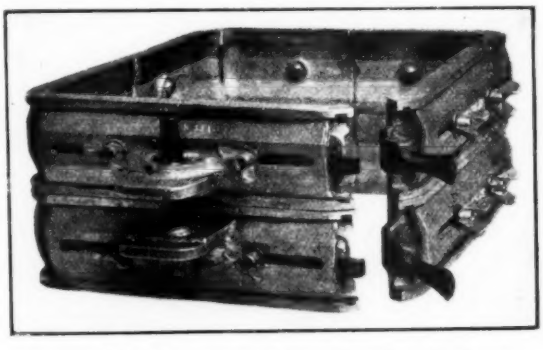
(2) In general, pouring at a high temperature yields less contraction than pouring at a low temperature because of the effect of gas occlusion.

(3) Other conditions being identical the smaller the cross section, the less the contraction—within limits.

(4) The extent to which piping occurs on casting an alloy is a factor in determining the suitability of an alloy for casting purposes since the amount of piping is an indication of the contraction in volume. The less the piping, the less the contraction.

Adjustable Aluminium Snap Flasks.

We illustrate below an aluminium snap flask which has been placed upon the market by Messrs. Brookes, Limited, of Oldbury, Birmingham. Besides carrying the advantages which aluminium as a light metal can give them, they are adjustable, both longitudinally and laterally. This is



accomplished by means of the winged nuts shown in the illustration. The adjustment allows of the size being increased from 12 in. × 10 in. to 16 in. × 14 in. The pins and bushes are made from hardened steel. The box is protected by British Patent No. 173,738, as well as a number of foreign patents. The utility of such a box is too obvious for foundrymen to necessitate our outlining them.

Some Notes on Cupola Practice, with Special Reference to Tap-Holes.

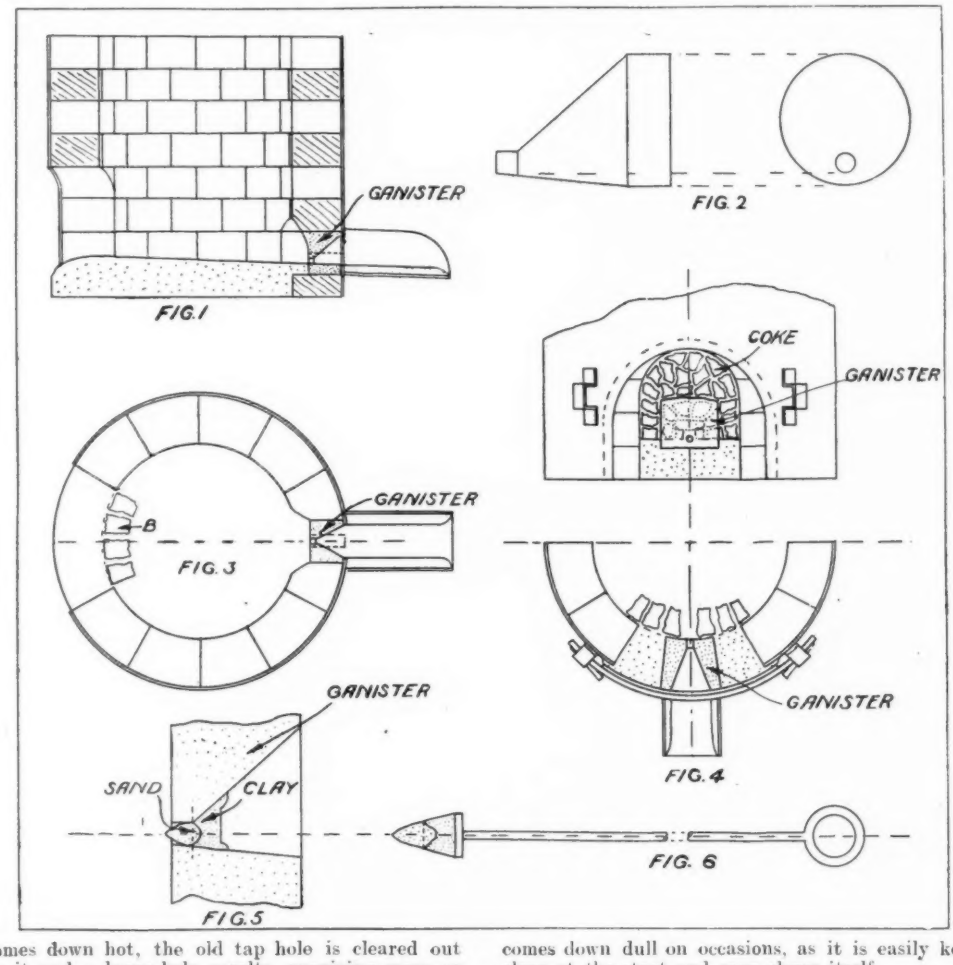
By Ecossais.

At some foundries it is quite a common experience for the cupola man to have what is termed an "iron hole," meaning by this that the tap-hole has become blocked by molten metal solidifying therein, which may be due to dull iron, too long a period between taps, or a tap-hole being incorrectly made. At such times a long bar, struck by a sledge hammer, is directed at the iron plug to force a passage for the metal to flow again. This bar sometimes gets fast and breaks off short, leaving matters worse than they were before, and a fresh hole has to be made either on one side of, or above, the old hole. After a time, if the metal comes down hot, the old tap hole is cleared out by it and a large hole results, requiring more or less heroism to plug again. If the bar does not fail and the plug of iron is removed by driving in, the resultant hole is also difficult to plug, and unless a crane ladle is in position may result in some of the operators being burned.

With a skilled furnaceman a refractory tap should be a rare occurrence, but every foundry is not sufficiently fortunate enough to possess one. On a few occasions it has been the writer's luck to have to train a man for the job of furnaceman, and certainly in two cases the man had never been inside a foundry before nor seen molten metal; in one case of a foundry just starting, the writer was the only person to have seen molten metal before.

To avoid trouble with the tap-hole in the latter case, a wooden plug was made of the shape shown in Fig. 2. This was placed in position in the space left in the brickwork opposite the spout for the purpose, fairly stiff ganister being then rammed round it from the inside and made level with the end, tapering off to the brickwork all round. When made quite firm, the sand bottom can be put in the cupola and the plug then drawn. If the ganister is sufficiently stiff no sagging will take place, and the heat of the furnace from previous day's cast further stiffens the ganister. The actual tap-hole is not more than 1 in. long, and after being dried by the lighting off fire is baked quite hard by the blast before any metal comes down.

Fig. 1 shows a section of a cupola having a thick lining of firebrick and the tap-hole made as described, with a recess at *A* to avoid having the tap-hole too far in from the shell, making it more accessible to the tapper-out. A short spout is also an advantage, especially when the first iron comes down dull on occasions, as it is easily kept clear at the start and soon clears itself.



Another operation to control is the closing up of the breast opening, as, if this is done correctly, there is no fear of a run-out at this point.

At *B* Fig. 3 is shown the correct position for setting the backing of coke, the outside of this being set to the same approximate radius as the inside of the brickwork. After the fire has burned up to the tuyere level, this opening can be closed with sand, rather damp for the first layer, the remainder being rather damper than that used for moulds. In addition to making this sand firm, the back plate is "tried" to, to get a proper bed, and finally, after the plate is fixed, the space between it and the shell is rammed tight with damp sand.

With a sand bed one important thing very often ignored is the necessity for some outlet for the escape of steam and gases formed when the metal rests upon it. Three or four ¾-in. holes left near the bottom of the back plate, through which a rod is passed after making up the back, serve for this purpose, but must not approach too near the face of the sand-bed in bottom of cupola.

With a furnace requiring the tap-hole to be made on the same side as the breast opening a different method must be adopted from that shown in Figs. 1 and 3. Whilst some furnacemen build up the opening with bricks, leaving a sand tap-hole, this is not necessary. It is not possible to make the tap hole "good" from the inside, so a bar is laid in position on the bottom of the opening the size the hole requires to be, and covered over with stiff ganister level with the top. Next a square brick of stiff ganister is laid up to the coke and over the bar so as to leave a good straight face on what will be the inner side of the tap-hole. The remaining space of the breast opening is made up as in making up the back previously referred to, and the front plate fixed in position, this plate having a hole in about 6 in. across; the spout being about 12 in. long.

The front of the tap-hole is now cut out to the shape of the block shown in Fig. 2, and the length of the tap-hole (not more than an inch) determined by a piece of wire bent cleaner-fashion. As an alternative to using wet ganister for making up a tap-hole, the block Fig. 2 may be incorporated in a frame or box and tap-hole blocks made in this with ganister, dried slowly and baked, a few of these always being kept in stock.

An undesirable form of tap-hole is indicated by dotted lines in Figs. 1 and 3, being a long parallel opening, of necessity large to avoid any solidification, and difficult to close. Even then tapping must be at short intervals or solidification will occur, and there is also much risk of the clay plug being forced out. Some furnacemen are afraid to risk a hole as shown in Figs. 1, 3, and 4, in case it should burst out, but as already stated, the ganister is quite hard and firm by the time any metal passes through. Nevertheless, they make a tap hole with sand because it is easier to make a fresh hole if the original one should make up.

Fig. 5 shows an enlarged section of the tap-hole with clay plug in position, and on reference to Fig. 6 it will be seen that the clay is shaped like the frustrum of a cone, a slight hollow being formed at the face with the finger end, the whole being made into a complete cone with sand. By this means the tap-hole proper is never made up with clay, but with sand, the clay adhering to the sides of the conical-shaped and enlarged portion of tap-hole. In tapping, this clay is easily picked away with the tapping rod, which has a tapered chisel point, and the pressure of the metal in the furnace is then invariably sufficient to force the sand out, leaving a clean tap hole.

Dealing with Leaks.

In case of a leak at the breast opening, or the bottom of a drop bottom furnace, it is often quite sufficient to stop the leak by stopping the blast for a few minutes and drawing off all the metal giving the metal a chance to cool, and by solidifying itself closing the leak. With more serious leakages, however, it may mean removing the breast plate and making up afresh, and in the case of a drop bottom with breast opening, cutting away the lower portion of the sand bed until the leaky place is reached, fresh sand being then well rammed in and the breast closed again. When no breast-opening exists and stopping the blower for a few minutes is not effective, it is almost certain to involve dropping the bottom.

The causes of leakage with a dropped bottom may be a damp bed, one rammed too hard, the sides adjoining the brickwork not being rammed hard enough, or the slipping of the support for the bottom plate causing a subsidence of the materials in the furnace. When, through an improperly made tap-hole a burst-out occurs, it is better to empty the furnace of molten metal and stop the blast. A large clay cone can then be forced in the hole, this clay being softer than usual so as to stick to the sides of the hole, a new hole being then formed as in Fig. 4. This is left open and the blast put on, and after tapping a small quantity of metal, closed by a small plug and worked carefully for a few taps, after which there should be no further trouble.

The writer has at various times seen recorded, and heard of different elaborate mixtures for tap-hole plugs, but has generally obtained satisfaction from ordinary clay with a little coal dust and sand, more or less dry sand being use according to whether the clay was "fat" or "lean."

Book Review.

PATTERNMAKING. By Edward M. McCracken and Charles H. Sampson, published by Messrs. Scott Greenwood & Son, 8, Broadway, Ludgate Hill, E.C.4. Price 10s. 6d. net.

Of books on patternmaking there is no end. Most of them are published in America, but the most practical and useful books are by English authors. This new addition, which has been written for students attending either technical, trade, or vocational schools, is of a very elementary nature indeed. Some forms of hand tools are well represented in text and illustrations, whereas patternmaking machines are illustrated only. A chapter is given to the definition of many terms used in the foundry, and there are several photographs of foundry equipment. The major part of the book consists of exercises so graduated that they form a course of practical work in which many patternmaking principles are introduced. The exercises are very neatly drawn and brief explanation of procedure, in doing the work, is given in connection with each one. Additional drawings are given at the end of the course to be used for testing the capabilities of the individual student.

The authors assert that they have endeavoured to illustrate a definite principle in each exercise to enable students, who have completed the course, to make any pattern of the usual type. It is not clear what a pattern of the usual type is, as, apart from work of an elementary character, the type of pattern varies much in different localities. It is also stated that the student should possess the information as it is presented in the text if he expects to become a first-class patternmaker. With much of this we are in agreement, but patternmaking is too comprehensive a craft with which to deal adequately in a course of 24 exercises and a few pages of explanatory matter. Patternmaking not only involves the manipulation of hand-woodworking tools, but a sound knowledge of geometry, machine construction, and design, the possibilities and manipulation of woodworking machinery, the principles of moulding and some knowledge of metals and alloys.

Broadly a pattern may be similar to a required casting or it may only possess a partial similarity externally. When and under what conditions are each used? Castings are frequently cored partly about the outside as well as inside. Then, dealing with the construction of patterns, there are so many methods all based on sound principles that the student would be in a dilemma in determining which to adopt in a specific instance. Patterns may be carved from the solid, built up to provide a solid exterior, framed up, made skeleton fashion representing the external shape only or both internal and external shapes; or, only a part of a pattern may be made. Instead of a whole or part pattern sweeping or striking boards may be more profitably employed, either to form the whole mould or a part of it. A pattern may be formed from a combination of these structures. It is in determining the form of construction for a given job that the inexperienced are so frequently baffled. The design of the work must be considered, the method of moulding, and the number of castings required.

Patternmaking demands initiative and a course such as is outlined in this book does not necessarily encourage this quality. The student does need the information given, but he will need very much more to become a first-class patternmaker. The exercises are really a rapid progression over the first two years of apprenticeship. The fault of the apprenticeship system is that principle is not clearly distinguished and it is difficult to see how a student by learning how to make a few of the commoner types of patterns, from the explicit instructions given here, will improve on the knowledge gained in the ordinary patternshop. A knowledge of principles separated from specific work may be difficult to learn, but, once thoroughly understood, they can be applied to the innumerable designs encountered in everyday practice.

In one respect the book is excellent. It is well produced on art paper, and the photographs and line drawings are a credit to both authors and publishers.

"B. S." AND "J. E."

Institution of British Foundrymen.

LANCASHIRE BRANCH.

The Coremaker and the Moulder.

At a meeting of the Lancashire Branch of the Institution, held on May 5 at the College of Technology, Manchester, Mr. R. A. Miles presiding, a discussion upon the relationship between the coremaker and the moulder was opened by Mr. T. Makemson. He said that during recent years a number of Papers and addresses had been given before various branches on the subject of training apprentices, and some of them were very able and complete, but it did not appear that a sound basis of agreement had been reached. On some things they were agreed—for instance, that it was necessary to do something to improve present methods and that a supply of apprentices must be obtained—but they were not of one mind as to how this should be brought about. He thought much of this disagreement arose from not being quite clear what they were aiming at, whether to train a highly-skilled foundry manager or a metallurgist or, on the other hand, a competent moulder.

Separation of the Trades.

In Lancashire, moulding and coremaking were two separate and distinct trades, and a boy who was apprenticed to either was not always taught something about the other. For instance, the apprentice moulder in many instances would be given some coremaking to do, but it was not sufficient to enable him to make a complicated core. On the other hand, the apprentice coremaker seldom got experience of moulding. With journeymen, the line of demarcation was even more distinct; for the most part, the coremaker and the moulder stuck to their separate jobs. But in some parts of the country, particularly on the North-East Coast and in parts of Scotland, a somewhat different system prevailed, and the apprentice moulders very largely made their own cores. When several men were occupied in making a large job, one or two men were told off to do the coremaking, and became expert, in a sense specialists, in that work, but they were still moulders, and were competent to do the work of moulding if it should be required of them.

Division Inadvisable.

It had been suggested that the moment was opportune for reviewing the relationship between the two trades, and that the compartment system should be abandoned, the apprentice being trained both as a coremaker and as a moulder, so that he could be put to either class of work. One objection that might be raised to this proposal was that it was a step in the wrong direction, that modern methods more and more tended towards specialisation. Other things being equal, the man who spent all his working time on cores would become more expert in dealing with them than a man who had to change over to moulding. From this specialisation the employer reaped certain benefits. On the other hand, the other system meant that a man would be able to tackle a greater variety of work, and when one branch was slack, he could pass to the other; from the employer's point of view, it was an advantage that labour should be fluid and mobile. That advantage might be easily overestimated, because usually, when the moulder was busy, the coremaker was busy also, and vice versa.

Three points had to be considered:—(1) Was any change necessary at all? (2) Should the barrier be entirely abolished and the two trades merged in one, the apprentice being trained as a foundryman to do both jobs? (3) Should a distinction be maintained and a boy apprenticed as a coremaker or as a moulder, but given an opportunity of acquiring some knowledge of the other job? Personally, he had not come to a definite conclusion which of those three courses had the strongest arguments in its favour, and it was primarily for the purpose of considering these questions that the present discussion had been initiated.

Apprenticeship Training.

Apart from that specific question, he might refer briefly to the general question of apprentice training. They had heard reference made before to the difficulty of getting suitable lads to enter the foundry trade. At the moment that difficulty might not be great, because the demand for labour was slack and there must be thousands of boys who had left school in the last 12 months and could not get jobs. Many of them must be glad to take anything that came along. But when trade became good, boys of the type desired might be unwilling to come, and it was well, therefore, that the actual conditions and prospects of the foundry trade should be accurately understood. He did not think it was worse than any other trade. Indeed, he was inclined to think it a good deal better than most of them. But it suffered from a bad tradition, and people thought far worse of it than it deserved. The improvement in conditions and status during the last few years had been considerable. The foundry had ceased to be the Cinderella amongst the engineering workshops. Employers had begun to realise that it was expedient from the commercial point of view, apart from the effect upon the workpeople, that the foundry should be properly arranged and adequately equipped. A great deal more attention was paid to it, and the personal standard among the people engaged in it was higher. If a lad of intelligence would put his back into his work and try to make a success of it, there was no branch of the engineering industry which offered better prospects.

Economic and Craft Considerations.

MR. W. H. MEADOWCROFT said this subject was perennial, and there were two sides to it, the economic side and the craftsmanship side. It was the economic side chiefly that had brought this matter to the front recently, and it was one they could not properly deal with at that meeting. In his opinion, all practical foundrymen would agree that the moulder should have a knowledge of coremaking. The division between the two branches was largely a matter of convenience. It used to be said that a man who was not fit for moulding could be turned into a coremaker, and before the war it often happened that a man who had been wheeling loam was put on to coremaking. Of course, he received less remuneration. During the war, however, it came to be regarded as a matter of course that the remuneration should be equal in both sections, and, with the return to normal conditions, this question cropped up.

With regard to the apprenticeship question, he thought that would right itself eventually when the bad conditions of which they had heard were removed and the foundries were made suitable for apprentices. He did not think special training was required before apprenticeship. A bright lad who came with a general education should do well.

Separation of Trades Recent.

MR. SYDNEY SMITH said Mr. Makemson had dealt with the generalities very lucidly, and left it to them to arrive at a decision. Some 50 years ago there was no question whether a man was a coremaker or a moulder; he had to do the job that was given him, whether it was green sand, dry sand, or in loam. That, of course, gave a wider experience and led to an interchange of ideas. So there was something to be said for the old-fashioned way of making the apprentice moulder spend a year or two at coremaking. Bickering between moulders and coremakers, and also between the foreman moulder and the foreman coremaker, put other people in an unfortunate position, and an impartial decision regarding a waster might prove unsatisfactory.

On the general question of the status of the foundryman, he thought that had risen very much in late years. One reason was the work done by the Institution, but some credit was due to individual foundrymen. In his opinion, it was one of the most scientific of trades, and one of the most artistic. The outlook now was very promising indeed, and some of the best brains in the country were engaged in it.

Moulding Skill Superior.

MR. FIST agreed with what had been said about keeping the two sections connected with one

another. It was very convenient when one department was slack; there was no necessity to discharge a man, but he was put on to the other work. Nowadays, cores involving the use of oil and sea sand are usually made by boys, whereas previously it was a skilled man's job. It obviously follows that the major portion of the skill is no longer required. This factor is emphasised by the modern tendency to utilise machines which make better and stronger moulds.

MR. HOGG said he believed it would be a good thing if the coremaker learned something about moulding, and *vice versa*. He believed with Mr. Smith it was one of the finest trades in the country, and one of the most scientific. There were certainly a lot of jobs that could be done by lads or by unskilled labour, but there was room for the expert, thoroughly-trained foundryman.

Influence of Machine Moulding.

MR. GRIMWOOD said he was disappointed that machine moulding had not been mentioned and that the whole subject should be considered bearing in mind this aspect. The intensive introduction of machine moulding was a factor which foundrymen must realise, and that in a few years machines for coremaking would be installed generally. Specialisation would be practised to an extent far exceeding what had been known up to the present, and the line of demarcation between the ordinary moulder and the machine moulder would become more strict. In point of quantity and quality, the output of the ordinary floor moulder was not comparable with the output of the machine moulder. In making small cores, girls could do the work better, quicker and more cheaply than boys; in saying that, he was not referring to any difference of wages, but a girl would stick at her work, while a boy had a tendency to wander.

MR. SUTCLIFFE remarked that his own experience was that a moulder could be set to do coremaking and make a success of it, but no satisfaction was got from attempting to do the reverse. He thought that coremaking and moulding should be two separate trades, which would allow of intensive training and prevent the making of "jacks-of-all-trades." The training of a moulder is the more difficult, perhaps on account of the fact that practically all the coremakers' work is stoved.

MR. SMITH said the reference to the introduction of machines induced him to repeat the advice he had given to others: "If you find a machine is going to deprive you of your work, go and work at the machine."

MR. GRIMWOOD pointed out that it was not usual in the foundry to put skilled labour on machines. Some time ago he was at a pipe-making foundry, where there were 50 men employed, and the only skilled man was the foreman.

Coremakers Defunct.

MR. MASTERS thought the discussion had wandered from the point. What they ought to concern themselves about at the moment was the training of the lads who were coming along. His opinion was that they should be made foundrymen, not merely moulders or coremakers. Looking at the matter from the economic point of view, he thought the specialised coremaker was defunct to-day. If it was at all complicated, the moulder made the core; if it was of a straightforward character, it was done by machines.

The CHAIRMAN (Mr. R. A. Miles) said the matter depended upon local conditions. In some parts of the country the division between moulders and coremakers existed, elsewhere a man was a foundryman, and made cores or moulds as the occasion required. As to the coming of machines, when skilled men took them on, there would be better machines and better production. Specialisation was bound to come, and it was necessary to have skilled workmen. He agreed with Mr. Makemson that apprentices should be trained to make both cores and moulds.

MR. MAKEMSON said it was futile to think of stopping the introduction of machines, but it would be a very long time, if ever, before the skilled foundryman was not wanted. Many castings now made required the attention of skilled men; his imagination failed to conceive the possibility of their being made by semi-skilled men on machines. Repetition work, of course, was another matter.

A vote of thanks to Mr. Makemson was passed unanimously on the motion of Mr. Pell, seconded by Mr. Smith.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—After carefully reading the highly interesting Paper on "Modern Brass Foundry Alloys" by Mr. Rowe, I remain doubtful whether it is normally possible to obtain a gunmetal or a phosphor bronze able to withstand an intermittent working pressure, such as an injecting pump for a hydraulic press of 4 tons per sq. in.

Should the author of the Paper or any fellow-member of the I.B.F. be able to enlighten me on the subject, I should be very obliged.—Yours, etc.,

JAIME COLL, Member I.Brit.F.

Fundición de San Antonio, S.A.,
Sevilla, Spain.

Separating Charges in the Cupola.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The discussion raised by your leader "Proof Wanted" has now been condensed to the following: Does the lower melting point constituent of common iron liquate out and contaminate a different charge of hematite in the same heat?

The lower melting point constituent in mind is evidently the phosphide eutectic or iron phosphide (Fe_3P), which has a composition of 1.7 per cent. phosphorus, and has a melting point of just under 1,000 deg. C.

It is only reasonable, therefore, to expect this constituent to liquate out from its still solid body, pig-iron or scrap, in a zone where this temperature exists. The actual fusion zone of the cupola has a temperature of about 1,400 or 1,500 deg. C., and the position of this and its size govern the melting conditions existing in the cupola.

The blast combines with the hot carbon of the fuel and forms carbon dioxide.

$$2O + C = CO_2.$$

This represents the actual fusion zone. The excess carbon dioxide now takes up or reacts with more of the incandescent coke to form carbon monoxide, and heat is absorbed by this reaction, so that there is a sharp fall off in the temperature outside the actual fusion zone.

$$CO_2 + C = 2CO.$$

This temperature is somewhere between 850 deg. C. and 950 deg. C., and decreases continuously to the top of the cupola, where heat only exists by convection from the combustion taking place below.

Therefore if the zone where 1,000 deg. C. exists is so near to the actual fusion zone, it is unreasonable to expect the iron phosphide to liquate out in large quantities sufficient to make a difference of 50 per cent. in the calculated mixture, or 1 ton of bad iron to 1 ton of good iron as suggested.

A remark by an "Old Furnaceman" calls for question. He says: "When 20 tons of iron are put in it is not difficult to tell when 20 tons are tapped out." *But it is*, and that represents another difficulty. Slag is formed as he knows, and has as a constituent ferric oxide, amongst other things, to the extent of 30-40 per cent. This iron has not come from the limestone, nor the coke ash, but represents a loss of actual iron charged in, and if 20 tons are charged, rather should he expect 18 than 20 tons at the tapping spout.—Yours, etc.,

C. W. HARMAN.

583, Bury Road,
Breightmet, Bolton.

Tentative Specification for Grey Iron Castings.*

1. *Process of Manufacture.*—No castings shall be made from direct blast-furnace iron without consent of the purchaser.

2. *Classification.*—The castings shall be required to pass the tests specified below, according to classification. The class of casting shall be specified on the drawing and also on the inquiry.

Class A. Important Castings.—Test-bars shall be cast on when possible. When it is not possible to cast the bar on the casting, or when the consent of the engineer is obtained to cast the bar separately, the same procedure as outlined in Class B shall be followed.

Class B. Other Castings.—Where these call for physical tests, the bar may be cast separately at the option of the foundryman. The requisite test-bars shall be preferably cast in duplicate sets of two bars each of the diameter specified in Section 3. Two bars are to be cast in a box, and the mould to consist of green or dry sand according to whether the casting is in green or dry sand. They must be cast from the same ladle of metal as the castings they represent, and at as near the same pouring temperature as possible. Any thermal or mechanical treatment of the test-bars must conform to that to which the main casting is subjected, and the test-bars must be left in the mould until nearly cold. The bars may be tested for transverse as cast or skin-machined at the option of the purchaser.

3. *Size of Test-Bars.*—The thicknesses of any casting shall determine the size of the test-bar required, namely:—

Bar 0.875 in. dia. cast 15 in. long, for all castings where no main cross section of the metal exceeds $\frac{3}{4}$ in. thickness.

Bar 1.2 in. dia. cast 21 in. long, for all castings where no main cross section of the metal exceeds 2 in. thickness or is less than $\frac{3}{4}$ in. thickness.

Bar 2.2 in. dia. cast 21 in. long, for all castings where no main cross section of the metal is less than 2 in. thickness.

4. *Transverse Test.*—The transverse test specimens, specified above, when placed horizontally upon supports 12 in. apart in the case of the 15 in. bar and 18 in. apart in the case of the 21 in. bar, and tested under a centrally applied load, shall conform to the following minimum requirements:—

Size of bar in ins., 0.875; distance between centres in inches, 12; minimum load in lbs. for Class A, 1,185; deflection in ins., 0.12; minimum load in lbs., Class B, 1,050; deflection in ins., 0.10.

Size of bar in ins., 1.20; distance between centres in ins., 18; minimum load in lbs. for Class A, 1,950; deflection in ins., 0.15; minimum load in lbs., Class B, 1,715; deflection in ins., 0.12.

Size of bar in ins., 2.20; distance between centres in ins., 18; minimum load in lbs. for Class A, 10,000; deflection in ins., 0.10; minimum load in lbs., Class B, 9,000; deflection in ins., 0.10.

Any bar 0.125 in. over size must be turned down to standard. The following table gives the allowance to be made for each variation of 1/20 in. above or below standard diameters, assuming the sides to be round and parallel:—

Dia. of Bar.	Class A.	Class B.
0.975 in.	1,639 lbs.	1,453 lbs.
0.925 in.	1,400 lbs.	1,240 lbs.
0.875 in.	*1,185 lbs.*	*1,050 lbs.*
0.825 in.	978 lbs.	880 lbs.
0.775 in.	823 lbs.	729 lbs.
1.30 in.	2,479 lbs.	2,180 lbs.
1.25 in.	2,204 lbs.	1,938 lbs.
1.20 in.	*1,950 lbs.*	*1,715 lbs.*
1.15 in.	1,715 lbs.	1,508 lbs.
1.10 in.	1,502 lbs.	1,321 lbs.
2.30 in.	11,426 lbs.	10 280 lbs.
2.25 in.	10,697 lbs.	9,628 lbs.
2.20 in.	*10,000 lbs.*	*9,000 lbs.*
2.15 in.	9,344 lbs.	8,400 lbs.
2.10 in.	8,696 lbs.	7,828 lbs.

5. *Tensile Test.*—The tensile test shall be made from one portion of the broken transverse bar, and when turned shall conform to the following dimensions for at least 2 in. in the centre:—

Bar, 0.875 in. dia. turned to 0.564 in. dia. = $\frac{1}{4}$ sq. in. area.

Bar, 1,200 in. dia., turned to 0.798 in. dia. = $\frac{1}{2}$ sq. in. area.

Bar, 2.200 in. dia., turned to 1.785 in. dia. = 2.5 sq. in. area.

The minimum requirements as to tensile strength shall be:—

Bar dia., 0.875; test-piece dia., 0.564; Class A, 12 tons per sq. in.; Class B, 10.0 tons per sq. in.

Bar dia., 1.20,; test-piece dia., 0.798; Class A, 11.0 tons per sq. in.; Class B, 9.0 tons per sq. in.

Bar dia., 2.20; test-piece dia., 1.785; Class A, 10.0 tons per sq. in.; Class B, 9.0 tons per sq. in.

6. *Additional Tests Before Rejection.*—Should the first test fail, the Inspector shall try the second set, or if the bars represent a number of castings from the same mixture, test-bars may be cut from any selected casting at the option of the manufacturer. If these tests fail, the casting or castings shall be rejected.

7. *Chemical Analysis.*—Where physical tests are specified the amount of any chemical element other than phosphorus shall not be specified, and then only its maximum percentage.

8. *Inspection.* — The representative of the Engineer (or purchaser) shall have free access to the works of the manufacturer at all reasonable times during the course of manufacture of the castings; he shall be at liberty to inspect the manufacture at any stage, and to reject any casting or material that is unsound or does not otherwise conform to the terms of this specification.

9. *Testing Facilities.*—The manufacturer shall supply and prepare all test-bars at his own cost. Failing facilities at his own works for making the physical tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

* To be submitted on June 12 to the Manchester Conference of the Institution of British Foundrymen.

Personal.

MR. R. HIRST has been elected a director of Webster & Company (Sheffield), Limited, Millhouses, Sheffield.

MR. H. D. BRUNTON AND MR. S. COLE have been added to the board of Spensers (London), Limited, 6, London Street, Paddington, W.2.

MR. D. V. L. FELLOWS has been elected a director of the Patent Die-Castings, Limited, 64, Strode Road, Willesden Green, N.W.10.

MR. W. CLARK, a director of Vickers, Limited, has returned to Sheffield from a prolonged business trip abroad.

MAJOR W. GREGSON, formerly secretary and general-manager of Spencer-Bonecourt, Limited, has been elected to a seat on the board, and has been succeeded in the secretaryship by Mr. E. M. Catt.

MR. G. A. MITCHELL is now the chairman of the North Lincolnshire Iron Company, Limited, the other directors being Messrs. A. L. Leigh (managing), J. G. Stewart, C. G. Atha, S. J. Lloyd and J. Howard.

MR. E. C. GARDNER, who is a director of George Lillington & Company, Limited, 69, High Holborn, W.C.1, and North Road, Caledonian Road, N.1, is acting as secretary of the company.

MR. DONALD DOWNING, a member of the London branch of the Institution of British Foundrymen, has become associated with the India Iron & Steel Company, at their Herapur Works, Asansol, E.I.R., India.

MR. H. SIBILLE is managing director, and Mr. J. P. Bate a director of H. Sibille & Company, Limited, steel and iron merchants, 70, Victoria Street, S.W.1. The business was recently converted into a limited liability concern with a capital of £11,000.

MR. JAMES FIELDSEND is acting with the board of John Round & Son, Limited, in a consultative capacity. Mr. Isaac Milner, after serving the company for upwards of 18 years, has been compelled, on account of continued ill-health, to resign his position on the board, and Mr. Thomas Rhodes has been elected to fill the vacancy and at the same time will be managing director.

THE PARLIAMENTARY SECRETARY to the Department of Overseas Trade has appointed some additional members to his Advisory Committee, which now includes Mr. Arthur Balfour, J.P., Sir Charles Coupar Barrie, M.P., Sir William Ellis, Sir Algernon Firth, Bart., Mr. W. L. Hichens, Sir William Larke, Mr. Kenneth Lee, Sir Charles Mandleberg, Sir William Pearce, Lieut.-Col. D. Watts-Morgan, M.P., and Mr. H. C. R. Williamson.

Trade Talk.

Beyer, Peacock & Company, Limited, have removed their London office to Abbey House, Westminster, S.W.1, under the management of Mr. W. C. Williams.

Mr. G. Gordon Hazard is the secretary and Mr. C. Wright the director of Chas. Wright, Limited, stampers, diesinkers, etc., High Street, Edgware, who formerly traded under the style of Wright & Son.

Law, Markham & Company, Limited, engineers, have removed from Cromwell House, Fulwood Place, 33a, High Holborn, to 619-622, Bank Chambers, 329, High Holborn, London, W.C.1.

S. Birkett & Sons, (Cleckheaton), Limited, Craven Street, Hull, have taken over the business of Shally & Company, wire brush manufacturers and foundry specialists, of Hull.

Considerable damage was done by a fire on May 18 at the works of Shipham & Company, Limited, brassfounders, finishers, and coppersmiths, Hawthorne Avenue, Hull.

P. J. Parmiter & Sons, Limited, of Tisbury, have closed their Wolverhampton office. The directorate now comprises Mr. Arthur Adams and Mr. Charles Adams only.

The Still Engine Company, Limited, who have increased their capital from £300,000 to £303,750, in 300,000 £1 shares and 75,000 1s. shares, have added Capt. H. Riall Sankey, Sir Geo. Hadcock, and Mr. W. J. Still to the directorate.

T. G. Bell & Company, railway wagon owners and contractors, Bardon Chambers, King Street, Leeds, have converted their business into a limited liability concern under the style of T. G. Bell & Company, Limited.

The conference of the Federation of Engineering and Shipbuilding Trades at Nottingham, on May 17, decided to take steps within the next few weeks with a view to securing an improvement of wages and conditions in the shipyards.

Mr. J. W. Towers, shipbuilder and engineer, Cardiff and Swansea, has purchased the fixed plant and machinery of the works of John Payne, Limited, Bristol, together with three ships each 550 tons d.w. building to classification, one of which is practically ready for launching.

Green & Jackson, Grenville Buildings, 12, Cherry Street, Birmingham, have been appointed agents in Birmingham for F. & A. Parkinson, Limited, of Guiseley, Leeds, manufacturers of alternating current motors, and for Holden & Brooke, Limited, engineers, of West Gorton, Manchester.

With regard to the outbreak of fire at the works of Challingsworths, Limited, Phœnix Foundry, 296, Heath Street, Birmingham, referred to in our last issue, we are informed that the whole of the foundry and machine shops were completely gutted. The company, however, have secured another foundry, where business will be carried on as usual during re-construction.

The Engineering and Shipbuilding Trades' Federation at their recent annual meeting in Nottingham had under consideration the relation of the Boilermakers' Society with the Federation, and decided that in accordance with the rules of the Federation the boilermakers had ceased to be members of the Federation at the date on which they withdrew from the negotiations on the overtime and nightshift agreement.

The Government have decided that, as regards all works in respect of which grants are given expressly because of unemployment by the Unemployment Grants Committee, or by any Government Department, it shall be a condition of the grant that all contracts for or incidental to the works are to be placed in this country. This follows a similar condition with regard to schemes in respect of which guarantees are given under the Trade Facilities Act.

The North-East Coast Engineering Trades' Employers' Association have offered the following arrangement regarding lodging allowances to workmen :—5s. a day for the first week, to men sent away to another district and having to remain overnight; and 4s. a day after the first week. This to take effect from June 11, and to operate for twelve months, subject afterwards to one month's notice. The scale is now being submitted to the workers concerned.

Licences under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Alloa Shipbreaking Company, Limited, 204, St. Vincent Street, Glasgow; W. Goetz, 67, St. Mary Axe, London, E.C.3; Henderson, Forbes & Company, Limited, London House, Crutched Friars, London, E.C.3; C. L. McCann, 177, Lozells Road, Handsworth, Birmingham; the Pontardawe Coal & Metals Company, 71, Herbert Street, Pontardawe; L. K. Brindley, London; A. J. Coulls, London, and H. Mountain, London.

The National Union of Manufacturers have forwarded to the Minister of Health a copy of a resolution passed by them to the effect that "the Administrative Committee of the National Union, having considered the Government's attitude regarding the Rating of Machinery Bill, feel that the Departmental Committee it is proposed to set up will cause further delay in effecting a reform long overdue, and they appeal to the Government to reconsider their decision, and grant facilities for the Bill to be passed into law."

A disastrous fire broke out on May 17 at the works of Samuel Fox & Company, Limited, Stocksbridge, near Sheffield, being discovered by men coming off the night shift. Fanned by a strong breeze and fed by a large quantity of oil and grease the outbreak soon assumed great proportions. Three brigades were in attendance but it was impossible to make any headway against the blaze, and the men consequently confined their efforts to protecting the adjoining property. The rolling-mill plant was destroyed, but the firm have been able to make arrangements to carry out their contracts at other works in Sheffield.

The Sheepbridge Stokes Centrifugal Castings Company, Limited, of Chesterfield, recently formed to develop the process of the manufacture of castings under centrifugal pressure, are a combination of the Sheepbridge Coal & Iron Company, Limited, and Stokes Castings, Limited, of Mansfield. The two concerns have been associated for some time, but closer working arrangements have now been decided upon, for which purpose the centrifugal casting plant of Stokes Castings, Limited, will be transferred to new works at Chesterfield. Additional plant is also being erected, to permit of castings of much larger dimensions being made. Mr. F. W. Stokes is actively associated with the new concern.

Company News.

John Cartwright & Sons, Limited.—Capital £3,000 in £1 shares. Iron and brass founders.

Woodley Foundry, Limited.—Capital £1,000. Solicitor: W. H. W. Menzies, Mount Street, Manchester.

Pomeroy Foundry, Limited.—Capital £100. Solicitor: W. A. Zabell, 11, Queen Victoria Street, E.C.

Edge Lane Foundry, Limited, Edge Lane Foundry, Longsight, Oldham.—Capital £1,500 in £1 shares. Director: F. Maley.

John Round & Son, Limited.—Trading loss, £918; interest on loans, income-tax, etc., make net loss £2,815; debit balance brought in, £1,253; total debit, £4,067.

Maurice Avison, Limited, John William Street, Cleckheaton, Yorks.—Capital £1,000. Metal merchants, etc. Directors: M. Avison (chairman) and J. H. E. Avison.

Crest, Limited, Churchill Street, Smethwick.—Capital £3,000 in £1 shares, to take over the business of engineers, brass workers, etc., carried on by A. A. Harvey, F. Harvey and H. T. Clews as "H. Clews & Company."

Daws Textile Engineering Company, Limited.—Capital £4,000. Directors: J. Shreeves, B. J. Dykes (general manager), G. Watkin, and J. W. Allbrighton (managing director). Secretary: G. Watkin, 84, Glencoe Road, Sheffield.

Robert Cheyne & Company, Limited, 8, Grange Road, Middlesbrough.—Capital £6,000 in £1 shares (1,000 10 per cent. cumulative preference). Scrap and metal merchants. Directors: R. H. Cheyne and Emily Cheyne. Secretary: J. T. Ambler.

Monk Bridge Iron & Steel Company, Limited.—Loss for 1922, £29,424; deduct balance brought forward, £10,976; debit, £18,448; dividend on cumulative 6 per cent. preference shares for half-year to June, 1922, £7,500; total debit, £25,948.

Allen Everitt & Sons, Limited.—Profits, £29,300; brought forward, £4,714; depreciation, £11,382; reserves, £537; debenture interest, £4,000; interim dividend on preference and ordinary shares, £6,600; final dividends, 6 per cent. per annum, less tax, on preference shares, and 7½ per cent. per annum, free of tax, on ordinary shares, making 7½ per cent. for year; carry forward, £4,895.

German Trade with the Baltic.—It is reported that the Fried. Krupp Company have established a general agency in Copenhagen with a large stock of machinery for trade with the Scandinavian countries, the Baltic States and Russia. The principal of the agency is also a member of a new company formed recently in Berlin to export manufactures from the Essen and other large German firms to European countries.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The resumption of business in the Cleveland iron market since the holidays has disclosed few changes in the general position of the trade, which remains listless and without signs of an early improvement in the outlook. It is not surprising, however, that the uncertainty now prevailing as regards the European political situation should have a retarding effect upon business, and although for the present Tees-side makers are disposing of outputs under existing contracts, consumers are by no means coming forward freely with inquiries covering the next half-year's requirements. The selection of Mr. Stanley Baldwin as the new Prime Minister has undoubtedly created a feeling of confidence in business circles, but it is probably the bare truth to say that the trade outlook, as far as iron, steel and fuel are concerned, is much more dependent upon developments in the political situation abroad, and particularly in the Ruhr. In the meantime, conditions on the market are weaker, last week's values being generally shaded. No. 1 still stands at 130s., with No. 3 G.M.B. easy at 120s., No. 4 foundry 117s. 6d., and No. 4 forge 115s.

While hematite has been showing a rather easier tendency, the change has been less pronounced than in the case of foundry iron, the former, owing to its lower price, being bought in place of the latter. Hence, East Coast mixed numbers is sometimes quoted at 122s. 6d., but can generally be bought at 120s., while No. 1 is at a minimum premium of 1s. per ton. In the West Coast area prices are maintained at the old level, Bessemer mixed numbers being quoted at £6 12s. 6d. per ton delivered at Glasgow and Sheffield, and £6 15s. for export. Low phosphorus iron is in steady demand by high-class steel manufacturers in the Midlands.

MANCHESTER.—Consumers in this district are still complaining that values of foundry iron are maintained at too high levels, but with fuel at present quotations there is little prospect of early relief in that direction. The nominal price for Midland foundry iron locally is still round 120s. per ton delivered, although it is probable that a small concession, not exceeding 2s. 6d. per ton, might be obtained in some cases. If the ironfounders of the district could get work which would pay on the present price of pig-iron they would not refuse to take in as much of the cheap scrap as they could get, and the fact that they are not doing so is good proof that orders for castings cannot be obtained under existing conditions.

THE MIDLANDS.—Very quiet conditions are reported in the local pig-iron industry, and although furnace outputs are going steadily into consumption, buying on forward account is on a restricted scale. The easing of quotations so far recorded indicates the weakening of demand for prompt delivery, but smelters reject the suggestion that they are destined to go still lower. In support of this view they point to the high price of coke. Until there is some relief in this direction they say lower prices for iron cannot be expected. Quotations now ruling at Birmingham are about as follow: Northamptonshire forge, 97s. 6d.; No. 3 foundry, 107s. 6d.; Derbyshire forge, 102s. 6d. to 105s.; No. 3 foundry, 110s. to 115s.; all net, f.o.t. furnaces.

SCOTLAND.—Conditions in the Glasgow iron market continue dull and uneventful, and prices have weakened further to 115s. per ton for No. 3 foundry at the furnaces. The decline has not brought about any improvement in the demand, and the small purchases now being made are for prompt delivery. The decline in values is confirming the consumers in their policy of day-to-day buying. The engineering founders are exceedingly quiet, with no improvement in sight, whilst the malleable works, though moderately busy, are buying very little pig-iron. Consequently, the consumption is being reduced to a minimum. There have been some small orders for Middlesbrough pig-iron placed by the Falkirk founders at 127s. 6d. for No. 3 and 122s. 6d. for No. 4 foundry. For No. 3 Scotch the quotation is 117s. 6d. f.o.t. Falkirk.

Finished Iron.

The position in the manufacturing branches of the trade remains practically unaltered, very little new business being reported, the few transactions transpiring referring mostly to those concerned with immediate requirements, while consumers appear inclined to postpone buying on forward account until the outlook becomes better defined. At present, however, the only department affected in this connection is that producing the commoner qualities of iron, such as bars for nut and bolt making. Lancashire makers have had to come down to £11 10s, and Staffordshire are 2s. 6d. to 5s. less. One of the reasons for this weakness is that Belgian bars have been more freely offered, the lowest price mentioned being £9 5s. delivered. Imported material is not altogether favoured, but difficulties such as these are bound to have some effect, especially at times when demand is slack. Satisfactory reports are still forthcoming concerning marked bars, but there is not so much pressure for crown and superior qualities, though quotations are maintained.

Steel.

Following the recent price movements reported in semi-products, there have been no further developments of note, business in all sections of the industry remaining quiet and featureless. The majority of manufacturers are, however, fairly well provided with orders in hand for some time in advance, makers of railway permanent way material and rolling stock having substantial contracts in hand, and makers of constructional steel also reporting some good orders in course of completion. Producers of "semis" are sanguine that the reduction in prices referred to above will stimulate demand. Its sole purpose was to enable consumers to ease their prices and remove the deadlock which has recently characterised forward business.

In the tinplate market buyers are still holding off all they can, although makers have shown more disposition to meet their views in regard to price. Second-hand sellers are plentiful at 23s. 1½d., a moderate amount of business being fixed up on this basis, but makers usually quote as follows for the standard sizes.—Coke tinplates, IC, 14 x 20, 112 sheets, 108 lbs., 23s. 3d. per box; IC, 28 x 20, 56 sheets, 108 lbs., 24s. per box; net cash, f.o.b. Bristol Channel ports.

Scrap.

Reports from the various markets for this class of material indicate little improvement in demand, with price movements, if anything, inclining to lower levels. In the Lancashire area, for example, the dulness of the market is expressed more acutely in cast scrap, for which the demand is totally inadequate. There are weak holders of this class of scrap who have to sell, and are offering good lots at very low prices, down to below 85s. per ton. Some holders of good broken machinery cast iron are standing out for 90s., but it is reported that they are unable to sell at this figure, although it is much below the current prices for foundry pig-iron. The fact is that ironfounders all over the country are expecting to see pig-iron prices very much lower. Hence they will not pay what dealers consider a fair price for cast scrap.

Metals.

Copper.—Movements in the standard copper market of late have inclined to somewhat irregular fluctuations of values, due to loss of confidence in the Continental political outlook, and partly, doubtless, to a lull in home demand following the recent holiday, and the reluctance of buyers to purchase beyond the limits of the immediate future. The position at the moment is consequently uncertain. Germany as a copper buyer has had to fall back during the last month or two, but the necessity of keeping the factories and works going is obvious, and any movement towards a settlement of the reparations question would undoubtedly be a good point for the metal market. In other directions the trade reports from the Continent are not very bright, the strike in Belgium and uncertainty regarding the industrial position in France being retarding factors. Current quotations:—*Cash*: Wednesday, £66 17s. 6d.; Thursday, £66 17s. 6d.; Friday, £65 15s.; Monday, £65 10s.; Tuesday, £65 2s. 6d. *Three Months*: Wednesday, £67 12s. 6d.; Thursday, £67 12s. 6d.; Friday, £66 7s. 6d.; Monday, £66 2s. 6d.; Tuesday, £65 12s. 6d.

Tin.—Following a somewhat heavy decline in values, the week's market for standard metal developed further irregularity, with values at lower levels. Sales in the East have again been small; shipments for the first half of the month were 2,400 tons, and for the whole month are estimated at 5,000 to 5,200 tons. The abstention of America from the market has, of course, been responsible to no small degree for the recent weakness, but it remains to be seen whether conditions on that side will justify much further support in the

near future. Failing such support, however, it is difficult to take a very hopeful view of the outlook. Current quotations :—*Cash* : Wednesday, £196 10s. ; Thursday, £199; Friday, £199; Monday, £196 15s. ; Tuesday, £197 15s. *Three Months* : Wednesday, £196 10s. ; Thursday, £198 15s. ; Friday, £199; Monday ,£196 10s. ; Tuesday, £197 10s.

Spelter.—Values for this metal have experienced a relapse since last reported, but the market continues fairly steady. Rudolf Wolff & Company report that the market presents a somewhat oversold appearance, and the possibility of the strike in Antwerp holding up shipments of Belgian metal has induced some "bear" covering, and has considerably strengthened the near position. Backwardation is once more in evidence. In America the price has also declined, but there is no pronounced weakness ; the output there for April amounted to 46,866 tons, consumption to 47,911 tons, which would indicate a not unfavourable position—as far as producers are concerned. Current quotations :—*Ordinary* : Wednesday, £30 12s. 6d. ; Thursday, £30 15s. ; Friday, £30 10s. ; Monday, £30 12s. 6d. ; Tuesday, £30 15s.

Lead.—The market for soft foreign pig rules firm, with an upward tendency in values. Consumers have shown more inclination to buy, and the improved position has induced a certain amount of "bear" covering. Stocks in warehouses are inclined to increase by reason of metal arriving in excess of trade requirements, but these are firmly held, and, with demand centring mostly on near delivery forward dealings are unimportant in volume. Current quotations :—*Soft foreign (prompt)* : Wednesday, £26 5s. ; Thursday, £26 5s. ; Friday, £26 2s. 6d. ; Monday, £25 17s. 6d. ; Tuesday, £25 17s. 6d.

Gazette.

A PETITION for the winding-up of the Widdop Engine Company, Limited, presented by Mitchell, Shackleton & Company, Limited, Vulcan Works, Patricroft, Eccles, will be heard in London on Tuesday, June 5.

THE PARTNERSHIP heretofore subsisting between Messrs. C. E. Jones and W. H. Wilkinson, manufacturing electrical engineers, Victory Works, East Parade, Bradford, under the style of James Tate, has been dissolved. Mr. C. E. Jones continues.

Institution of British Foundrymen.

Lancashire Branch Officers.

Mr. Tom Makemson draws our attention that an error appeared in our report of the Lancashire Branch annual meeting. Mr. Layfield was not elected on the Council, but Mr. Orme, who together with Mr. Grimwood filled vacancies caused by resignations. Mr. Layfield and Mr. Grandison were appointed auditors, and Mr. Makemson was re-elected honorary secretary.

The Manchester Conference.

We are informed that in the programme of the Institution of British Foundrymen Conference the paper by Mr. McEachern and Mr. A. Campion is described as "Core Irons" instead of "Core Sands." This paper is the joint work of a happy combination of the practical and technical sides of the industry, and the experience obtained during the last year has been of great value, and resulted in a good many economies and improvements in the foundry.

Obituary.

SIR JOHN AINSWORTH, Bt., a prominent Cumberland ironmaster, died at Gosforth on May 24, aged eighty. Sir John was M.P. for Argyllshire from 1903 to 1918, and formerly commanded the Cumberland Volunteers.

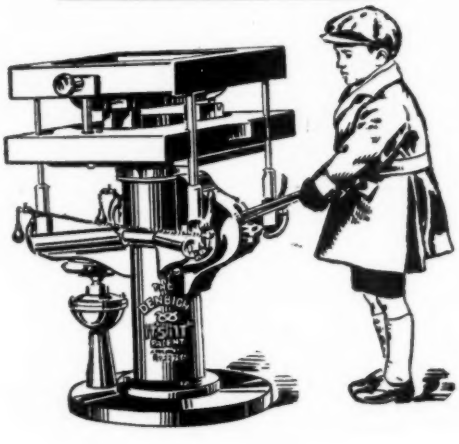
MR. ARTHUR LANG, who died at 9, Willowbank Road, Birkenhead, recently, after a short illness, was the eldest son of the late Mr. William Lang, for some time shipyard manager with John Jones & Sons, Tranmere Shipyard, and later with Cammell, Laird & Company, Limited, when they converted the small yard into the present modern concern. Mr. Arthur Lang was a worthy successor to the profession of his father; extremely just and conscientious, and very hard-working, he was known as a reliable shipyard official.

Reduce your overheads

By using the

"IT'S IT" PATENT HAND JOLT-RAM MOULDING MACHINE.

THE MACHINE WITH A PERFECT "JOLT" AND "DRAW."

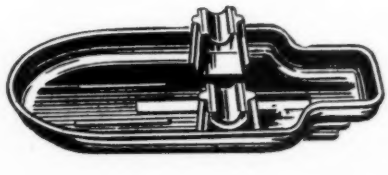


RUNNING COSTS NIL AND PRODUCTION EQUAL TO ANY POWER MACHINES ON THE MARKET.

May be used as a Hand Ram with all the advantages of its lift.

WEIGHTS MACHINES WILL TAKE—

No. 1	.. ..	2 cwts.
No. 2	.. ..	5 cwts.
No. 3	.. ..	9 cwts.
No. 4	.. ..	12 cwts.
No. 5	.. ..	20 cwts.



SOLE SELLING AGENTS :

JOHN M. TERRY & CO.,

5, 6 & 7, Great Hampton Street,

BIRMINGHAM:

TELEPHONE : 7400 Central.

TELEGRAMS : Athenian, Birmingham.

THE
MAGNESIUM CO., LTD.
34a, Buckingham Palace Road,
LONDON, S.W.1.

TELEPHONE: VICTORIA 3788.
TELEGRAMS: "OGNESIUMA," SOWEST LONDON.

Manufacturers of
METALLIC
MAGNESIUM
IN ALL ITS FORMS.

Powder, Turnings, Bar, Rod, Ingot, Ribbon, Wire, Extruded Sections, and Experimental Castings.
The Company specialises in the manufacture of all ALLOYS containing MAGNESIUM.

J.W.B.
"Eagle"
IRON CEMENT

Entirely BRITISH — Made in our own Works.
Invaluable for obliterating all kinds of defects in Iron and Steel Castings, Forgings, Pipes, etc.
A FINE DRY POWDER. WITHSTANDS GREAT HEAT.
Sample 1 *lb. tins* 1/6. *Bags:* 7 *lb.* 5/10, 28 *lb.* 23/4, 56 *lb.* 37/4, 1 *cwt.* 56/-
Carriage and Packing Free.
JOHN W. BAINBRIDGE, Ltd., 94, Moorgate, LONDON, E.C.2.

Every Description of Steel Stamps made on the premises by ex-service men. 33 years' experience. Personal Producer.
E. DEARMAN & SONS, —— 8, Eldon Street, Sheffield.

ERITH LOAM
J. PARISH & CO.,
ERITH.

SHOTTS IRON COMPANY, LTD.,
1, Castle St., Edinburgh.
Telephone: 8632 Cent. Telegrams: "Shotts" Edinburgh.

Branch Office—
141, West George St., Glasgow.

Approximate Analyses of SHOTTS Foundry and Forge PIG IRON

	No. 1.	No. 3.			No. 4.			
		Soft.	Medium.	Hard.	Soft.	Hard.	Mottled.	White.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Iron	91.57	92.21	92.31	92.46	92.83	93.75	93.85	94.14
Graphite	3.25	3.00	2.98	2.90	2.95	2.60	2.00	0.60
Combined Carbon	0.18	0.23	0.33	0.45	0.50	0.60	1.50	2.80
Silicon	3.25	2.80	2.60	2.40	2.00	1.40	0.90	0.56
Sulphur	0.02	0.03	0.05	0.06	0.07	0.10	0.15	0.30
Phosphorus	0.80	0.80	0.80	0.80	0.72	0.70	0.70	0.70
Manganese	0.93	0.93	0.93	0.93	0.93	0.85	0.90	0.90

In addition to PIG IRON we are producers of the following:—
COAL for Steam, Gas and Household purposes.
LIMESTONE for Blast Furnaces and Foundries.
LIME for Building, agricultural purposes, etc.
SHOTTS BRICK for building purposes.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	65	2	6
Three months	65	12	6
Electrolytic	73	0	0
Tough	67	10	0
Best selected	67	10	0
Sheets	102	0	0
India	88	0	0
Wire bars	73	0	0
Do. June	73	0	0
Do. July	73	0	0
Ingot bars	73	0	0
H.C. wire rods	78	10	0
Off. aver., cash, Apr.	73	4	8¼
Do. 3 mths., Apr.	74	0	9
Do. Settlement Apr.	73	4	0
Do. Electro, Apr.	81	11	3
Do. B.S., Apr.	77	13	1½
Aver. spot price, copper, Apr.	73	3	6
Do. Electro, Apr.	81	16	0
Solid drawn tubes		14¼d.	
Brazed tubes		14½d.	
Wire		11d.	
Yellow metal rods		7½d.	
Do. 4x4 Squares		9d.	
Do. 4x3 Sheets		10d.	

BRASS.

Solid drawn tubes	12¼d.
Brazed tubes	13¾d.
Rods, drawn	11d.
Rods, extruded or rolled	7½d.
Sheets to 10 w.g.	10¾d.
Wire	10¼d.
Rolled metal	10½d.

TIN.

	£	s.	d.
Standard cash	197	15	0
Three months	197	10	0
English	198	0	0
Bars	200	0	0
Chinese	197	0	0
Straits	200	15	0
Australian	200	15	0
Eastern	199	10	0
Banca	200	15	0
Off. aver., cash, Apr.	213	4	1½
Do. 3 mths., Apr.	213	11	1½
Do. Sttlment, Apr.	213	3	3
Aver., spot, Apr.	213	1	9

SPELTER.

	£	s.	d.
Ordinary	30	15	0
Remelted	29	0	0
Hard	27	0	0
Electro 99.9	35	0	0
English	31	10	0
India	28	0	0
Prime Western	31	0	0
Zinc dust	47	0	0
Zinc ashes	12	0	0
Off. aver., Apr.	34	6	8½
Aver., spot, Apr.	34	5	5½

LEAD.

	£	s.	d.
Soft foreign ppt	25	17	6
English	27	0	0
Off. average, Apr.	27	0	2¼
Average, spot, Apr. 26	19		1½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	40	0	0
Do. V.M. ex whf.	40	0	0
Dutch	36	0	0
Rods	47	0	0
Boiler plates	39	0	0
Battery plates	40	0	0

ANTIMONY.

	£	s.	d.
English regulus	30	10	0
Special brands	36	15	0
Chinese	26	10	0
Crude	23	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £13 2 6
75% £20 17 6

Ferro-vanadium—
35/40% 16/9 lb. va.

Ferro-molybdenum—
70/75% c. free 9/- to 9/3 lb.

Ferro titanium—
23/25%, carbonless 1/2½ lb.

Ferro-phosphorus, 20/23%, £29

Ferro-tungsten—
80/85%, carbon free 1/5½ lb.

Tungsten metal powder—
98/99% 1/10½ lb.

Ferro-chrome—
4/6% car. £23 10
6/8% car. £22 10
8/10% car. £21 10

Ferro-chrome—
Max. 2% car. £50 0
Max. 1% car. £60 0
Max. 0.70% car. £70 0
67/70%, carbonless 1/6 lb.

Nickel—99%, cubes or pellets £135 0

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £115

Metallic Chromium—
96/98% 4/6 lb.

Ferro-manganese (net)—
76/80%, loose £18
76/80%, packed £19
76/80%, export £20

Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	2	6	
Finished bars, 18% tungsten	3	0	

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ¾ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—£ s. d.	£	s.	d.
Heavy steel	4	10	0
Bundled steel & shrngs. 3 15 0	4	5	0
Mixed iron & steel 4 0 0	4	5	0
Heavy cast iron 4 0 0	4	5	0
Good machinery for foundries	4	5	0
Cleveland—			
Heavy steel	4	5	0
Steel turnings	3	6	3
Cast-iron borings	3	6	3
Heavy forge	5	5	0
Bushelled scrap	4	12	6
Cast-iron scrap	4	5	0
Lancashire—			
Cast-iron scrap	4	5	0
Heavy wrought	4	15	0
Steel turnings	3	12	6

London — Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	36	0	0
Lead (less usual draft)	22	0	0
Tea lead	20	0	0
Zinc	20	0	0
New aluminium cuttings	75	0	0
Braziery copper	48	0	0
Gun metal	48	0	0
Hollow pewter	160	0	0
Shaped black pewter	80	0	0

PIG-IRON.

N. E. Coast—
Foundry No. 1 130/-
Foundry No. 3 120/-
Forge No. 4 115/-
Mottled —
Hematite No. 1 121/-
Hematite M/Nos. 120/-

Midlands—
Staffs. common —
„ part-mine forge —
„ „ foundry —
„ Cold blast, ord. 190/-
„ „ roll iron 200/-
„ basic —

Northants forge 97/6
„ fdry. No 3 107/6
„ basic 115/-

Derbyshire forge 102/6 to 105/-
„ fdry. No. 3 110/- to 115/-
„ basic 115/-

Scotland—
Foundry No. 1 120/-
„ No. 3 115/-
Hematite M/Nos. 122/6

Sheffield (d/d district)—
Derby forge 107/6
„ fdry No. 3 110/- to 113/-
Lincs. forge 110/-
„ foundry No. 3 115/-
„ basic 120/-
E.C. hematite 130/-
W.C. hematite 132/6
All d/d in the district.

Lancashire (d/d eq. Man.) —
Derby forge —
„ foundry No. 3 120/-
Northants foundry No. 3 —
Cleveland foundry No. 3 —
Staffs. foundry No. 3 —
Lincs. forge —
„ foundry No. 3 —
Dalzell, No. 3 132/-
Summerlee, No. 3 132/-
Glengarnock, No. 3 132/-
Gartsherrie, No. 3 132/-
Monkland, No. 3 132/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.) £12 to	12	15	0
Angles	12	5	0
Tees to 3 united ins.	12	10	0
Nut and bolt	11	5	0
Hoops	15	0	0
Marked bars (Staffs.)	14	10	0
Gas strip	13	0	0
Bolts and nuts, ¾ in. × 4 in.	20	10	0
Steel—			
Ship plates	10	10	0
Boiler plates	14	0	0
Chequer plates	11	5	0
Angles	10	0	0
Tees	11	0	0
Channels	10	5	0
Joists	10	0	0
Rounds & squares 3 in. to 5½ in.	11	5	0
Rounds under 3 in. to ¾ in.	11	0	0
Flats, over 5 in. wide and up	11	10	0
Flats, 5 in. to 1½ in.	10	15	0
Rails, heavy	10	10	0
Fishplates	14	10	0
Hoops (Staffs.)	13	0	0
Black sheets, 24 g.	14	12	6
Galv. cor. sheets, 24 g.	19	5	0
Galv. fencing wire, 8 g. plain	18	5	0
Rivets, ¾ in. dia.	14	15	0
Billets, soft £8/5/0 to 8	15	0	
Billets, hard	10	15	0
Sheet bars £8/10/0 to 8	15	0	
Tin bars	9	2	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 4¼
Wire	1 4½
Rods	1 3
Tubes	1 6½
Castings	1 1½

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	32.76
No. 2 foundry, Valley	30.00
No. 2 foundry, Birm.	27.00
Basic	29.77
Bessemer	31.77
Malleable	31.77
Grey forge	31.27
Ferro-manganese 80% delivered	130.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	45.00
O.-h. billets	45.00
O.-h. sheet bars	45.00
Wire rods	51.00
	Cents.
Iron bars, Phila.	2.83
Steel bars	2.40
Tank plates	2.50
Beams, etc.	2.50
Skelp, grooved steel	2.45
Skelp, sheared steel	2.45
Steel hoops	3.30
Sheets, black, No. 28	3.85
Sheets, galv., No. 28	5.25
Sheets, blue an'l'd, 9&10	3.25
Wire nails	3.00
Plain wire	2.75
Barbed wire, galv.	3.80
Tinplate, 100-lb. box	$5.50

COKE (at ovens).

Welsh foundry 40/- to 45/-
„ furnace 30/- to 35/-
Durham & North. fdy. 47/6
„ furnace 39/6
Other Districts, fndy 45/- to 47/6
„ furnace 32/6 to 37/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	23/3
„	28×20, „	46/6
„	20×10, „	33/9
„	18¾×14, „	24/1½
C.W.	20×14, „	22/6
„	28×20, „	45/3
„	20×10, „	30/9
„	18¾×14, „	22/6
Terneplates	28×20, „	43/-

TUBES.

	Up to and incl. 6 in.
Gas ..	53¾% Tube prices
Water	48¾% are
Steam	43¾% now free.

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	17 10 0
Nail Rods—Square, round and flats ..	18 0 0

Keg Steel nom. £38 to £40

Faggot Steel nom. £30 to £32

Blooms—Single welded .. £10 to £11

Billets—Single and double welded .. .. £13 to £14

Pig-iron—Grey, white or mottled £7 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
May	23	66	17	6	dec. 12/6
„	24	66	17	6	No change
„	25	65	15	0	dec. 22/6
„	28	65	10	0	„ 5/-
„	29	65	2	6	„ 7/6

Electrolytic Copper.

May	23	76	0	0	No change
„	24	75	10	0	dec. 10/-
„	25	74	10	0	„ 20/-
„	28	73	10	0	„ 20/-
„	29	73	0	0	„ 10/-

Standard Tin (cash).

May	23	196	10	0	No change
„	24	199	0	0	inc. 50/-
„	25	199	0	0	No change
„	28	196	15	0	dec. 45/-
„	29	197	15	0	inc. 20/-

Tin (English ingots).

May	23	196	10	0	No change
„	24	199	0	0	inc. 50/-
„	25	199	0	0	No change
	28	197	0	0	dec. 40 -
„	29	198	0	0	inc. 20/-

Zinc Sheets (English).

May	23	40	0	0	No change
„	24	40	0	0	„
„	25	40	0	0	„
„	28	40	0	0	„
„	29	40	0	0	„

Spelter (ordinary).

May	23	30	12	6	dec. 17/6
„	24	30	15	0	inc. 2/6
„	25	30	10	0	dec. 5/-
„	28	30	12	6	inc. 2 6
„	29	30	15	0	„ 2/6

Lead (English).

May	23	27	5	0	No change
„	24	27	5	0	„
„	25	27	5	0	„
„	28	27	0	0	dec. 5/-
„	29	27	0	0	No change

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE MIXED NUMBERS F.O.T.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1915	.. 83 11	.. 88 6	.. 94 8	..107 0	..102 6	..101 3	.. 98 9	.. 98 7½	.. 96 6	..104 0	..124 1	..130 0	..106 11½
1916	..133 9	..140 0	..136 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..128 1½
1917	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6
1918	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6	..122 6
1919	..122 6	..122 6	..122 6	..122 6	..179 2	..190 0	..197 6	..200 0	..200 0	..200 0	..200 0	..200 0	..171 4
1920	..220 0	..220 0	..240 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..260 0	..251 8
1921	..240 0	..220 0	..180 0	..180 0	..180 0	..160 0	..160 0	..160 0	..160 0	..127 6	..117 6	..104 6	..162 2
1922	.. 97 6	.. 91 7½	..100 0	.. 98 6	.. 97 1½	.. 94 7	.. 93 6	.. 90 9	.. 89 7	.. 91 10½	.. 93 0	.. 93 2	.. 94 5½

AVERAGE PRICES OF STEEL RAILS.

Year.	Jan	Feb	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1908	.. 6 2 6	.. 6 0 0	.. 6 0 0	.. 5 15 6	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 10 0	.. 5 16 3
1909	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 0 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0	.. 5 5 0
1910	.. 5 5 0	.. 5 7 6	.. 5 7 6	.. 5 7 6	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 10 0	.. 5 8 11½
1911	.. 5 15 0	.. 5 15 0	.. 5 15 0	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 12 6	.. 5 13 1½
1912	.. 5 13 1	.. 5 15 0	.. 5 15 0	.. 5 15 7	.. 6 1 6	.. 6 6 3	.. 6 7 6	.. 6 8 0	.. 6 11 3	.. 6 12 6	.. 6 12 6	.. 6 13 9	.. 6 4 4
1913	.. 6 15 0	.. 6 14 4½	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 12 6	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 10 0	.. 6 12 0
1914	.. 6 10 0	.. 6 10 0	.. 6 6 3	.. 6 0 0	.. 6 0 0	.. 6 0 0	.. 5 14 0	.. 6 2 6	.. 6 13 9	.. 6 12 0	.. 6 7 6	.. 6 7 6	.. 6 5 3½
1915	.. 6 10 6	.. 6 17 6	.. 7 5 0	.. 7 12 6	.. 7 12 6	.. 7 17 6	.. 8 17 6	.. 9 2 6	.. 9 2 6	.. 9 7 6	.. 10 10 6	.. 8 6 6½
1916	..10 19 4	..11 0 0	..11 0 0	..10 18 9	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 9 10
1917	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1918	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6	..10 17 6
1919	..10 17 6	..13 7 6	..13 7 6	..15 0 0	..15 10 0	..16 0 0	..16 10 0	..16 10 0	..16 10 0	..16 10 0	..17 5 0	..14 12 11
1920	..18 15 0	..19 5 0	..20 7 6	..22 0 0	..23 0 0	..23 0 0	..24 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..25 0 0	..22 18 11½
1921	..23 5 0	..20 4 0	..18 0 0	..17 0 0	..15 0 0	..15 0 0	..14 0 0	..14 0 0	..11 12 6	..10 10 0	..10 0 0	..15 4 3
1922	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 10 0	.. 9 0 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 8 15 0	.. 9 4 2

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
5, MURZBAN ROAD, BOMBAY.
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ANGAPPA NAICK STREET, MADRAS.

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JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

IRON & STEEL SCRAP

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

ADVERTISER, with extensive knowledge and experience of modern methods in Machine Moulding, and good organiser, desires position as Foundry and Pattern-Shop Manager. Highest references.—Replies to Box 468, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOREMAN MOULDER required for a Scottish Steel Foundry; must be experienced in Green Sand work, competent to handle unskilled and semi-skilled labour; Foundry capacity, 100 tons per week; open shop; state age, experience, and salary required.—Apply Box 442, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY FOREMAN wanted immediately to take charge of Iron Foundry of old-established firm, North-East Coast. Applicants must be used to Repetition Work and the handling of rough labour. Normal output 100 tons per week. Apply, stating age, experience and salary required; house provided.—Box 470, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENCIES.

AGENTS wanted for all parts of the country, on a commission basis, to sell a Refractory Lining for Cupolas, etc.; must have good connections amongst Iron and Steel Foundries.—Apply, giving full particulars, to Box 452, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ENGINEER, with 25 years' experience, having offices in Aldersgate Street, E.C., is open to accept Agencies for London and district in Engineering Specialities or Foundry Requisites on commission basis. Thorough knowledge of Foundry Equipment. Also open to accept Consulting and Inspection work. At present in a position to introduce speciality for Foundry use to any firm having plant for working sheet metal up to ¼-in. plate. Actual turnover in this speciality has averaged during the last three years £7,000 per annum, and is capable of being largely increased by any firm having sufficient capacity.—Reply Box 472, Offices of THE FOUNDRY TRADE JOURNAL, 5, Duke Street, Adelphi, London, W.C.2.

PARTNERSHIPS.

ACTIVE PARTNER required for Foundry and Engineering Business, with about £1,000 capital; required for extension.—Box 458, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

TENDERS.

FOR SALE BY TENDER.

IRONFOUNDRY FULLY EQUIPPED WITH ALL PLANT. CUPOLAS, Etc.

MESSRS. JOSEPH RHODES & SONS, LIMITED, of Grove Ironworks, Wakefield, offer for sale by Tender

THE following Ironfoundry—

THE SITE is freehold and covers an area of 1,865 square yards or thereabouts.

ALL BUILDINGS thereon are well constructed of brick, and comprise—

IRONFOUNDRY in all 13,136 square feet or thereabouts. CORE STOVES, BLOWER HOUSE,, PATTERN STORE, FETTLING SHOP, Etc.

MOTIVE POWER AND GEARING. WATER, GAS, AND FIRE SERVICES. ELECTRIC LIGHT AND POWER INSTALLATION. TRADE FIXTURES. LOOSE TOOLS AND UTENSILS. TRAMWAYS BOGIES, Etc.

THE PLANT consists of 10 tons electric overhead travelling crane, jib cranes, sand mixer, moulding machines, loam mill, cupolas 4 ft. 3 in. dia. and 3 ft. 9 in. dia., and staging, fans, hoist, grinders, etc. Large quantity moulding boxes, ladles, shanks, etc.

POSSESSION CAN BE GIVEN IMMEDIATELY ON COMPLETION.

Application for permission to view should be made to the Firm at the address given below.

J. R. and Sons, Limited, do not bind themselves to accept the highest or any tender.

Tenders endorsed "Foundry" to be delivered not later than June 12th, to—

JOSEPH RHODES & SONS, LIMITED,
Grove Ironworks, Wakefield.

TENDERS.—*Continued.*

ADMINISTRATIVE COUNTY OF LONDON.

SALE OF ELECTRICAL POWER STATION MACHINERY.

THE LONDON COUNTY COUNCIL invites Tenders for the PURCHASE and REMOVAL of GENERATING SETS, BOILERS, COAL CONVEYOR, COOLING TOWER, FEED PUMPS and WATER-SOFTENING PLANT.

The plant may be inspected at the London United Electric Tramways Power Station, 74, High Road, Chiswick, between the hours of 10 a.m. and 4 p.m. ON ANY WEEK-DAY, except Saturday, from 4th to 11th June, 1923, both dates inclusive, by appointment with a representative of the Council.

Particulars and Form of Tender may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C.2.

Tenders must be delivered to the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, not later than 12 Noon on TUESDAY, 12th June, 1923. No Tender received after that time will be considered.

The Council does not bind itself to accept the highest or any Tender.

JAMES BIRD,
Clerk of the London County Council.

WE ARE BUYERS
OF
FOUNDRY STORES IN LARGE QUANTITIES.

SCHEDULE A.

Shovels.
Riddles.
Brushes.
Hammers.
Buckets.
Cans.
Ladles.
Mallets.
Bellows.
Goggles.
Sand Blast Helmets.
Sand Blast Gloves.
Armoured Hose.
Wheelbarrows.
Trucks.
Grinding Wheels.
Hand Leathers.
Footguards.

SCHEDULE B.

Plumbago.
Core Gum.
Treacle.
French Chalk.
Wax Vents.
Rosin.
Tapers.
Cut Brads.
Nails and Panel Pins.
Wire.
Perforated Tin.
Crucibles.

Manufacturers wishing to Tender are invited to send all useful details to "FOUNDRY," TURNER'S ADVERTISING OFFICES, 48, Frederick Street, Birmingham.

PATENTS.

INVENTORS Advice, Handbook and Consultations Free. KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London; 36 years' references.

MACHINERY.

FOR SALE.—One Tilting Cupola, 20 in. inside dia., made by Jas. Evans & Company, complete with stand, fan and firebricks; cost £135; had practically no use; will accept low price to clear.—WELLWORTHY, LIMITED, Lymington, Hants.

MACHINERY, PLANT, &c.

VERTICAL BOILER FEED PUMP, by G. & J. Weir; 21 in. steam cyl., 14 in. water, 24 in. stroke.

Ten VERTICAL BOILER FEED PUMPS, by G. & J. Weir; 11 in. steam cyl., 7½ in. water, 7½ in. stroke.

Two 26¼ kw. Steam GENERATING SETS; Compound Engine direct-coupled to Generator; 105 volts, 500 revs., 250 amps.

Three GENERATING SETS; Compound Engine by Bellis & Morcom, direct-coupled to Laurence Scott Generator; 105 volts, 500 amps, 400 revs.

Nine nearly new LOCO-TYPE BOILERS, 10 n.h.p.; reinsure 150 lbs. working pressure.

HORNSBY WASTE HEAT WATER-TUBE BOILER, about 40 h.p.; reinsure 160 lbs. pressure.

"GALLOWAY" BOILER, 24 ft. x 6 ft. 8 in. diameter; reinsure 100 lbs. pressure.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.